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The dynamics of variation in individuals

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Abstract

This paper examines the factors conditioning the production of linguistic variables in real time by individual speakers: the study of what we term the *dynamics of variation in individuals*. We propose a framework that recognizes three types of factors conditioning variation: sociostylistic (s-), internal linguistic (i-), and psychophysiological (p-). We develop two main points against this background. The first is that sequences of variants produced by individuals display systematic patterns that can be understood in terms of s-conditioning and p-conditioning (with a focus on the latter). The second main point is that p-conditioning and i-conditioning are distinct in their mental implementations; this claim has implications for understanding the locality of the factors conditioning alternations, for the universality and language-specificity of variation, and for the general question of whether grammar and language use are distinct. Throughout the paper, questions about the dynamics of variation in individuals are set against the typical community-centered variationist perspective, with an eye towards showing how findings in the two domains, though differing in explanatory focus, can ultimately be mutually informative.

Keywords

variation; dynamics; quantitative; sociolinguistic cognition; language use; locality; alternations

1 Introduction

Since the 1960s, the quantitative patterning of intra- and inter-speaker variation has been the primary focus of study in variationist sociolinguistics. Research in this tradition has documented the sensitivity of variation to social factors, such as class and gender, as well as to grammatical structure. Work in this vein has produced highly successful *community-level* profiles of the factors that affect a given linguistic variable. These profiles are, in the typical case, *static*, in the sense that they provide a snapshot of the social and linguistic parameters that characterize a particular community's distribution of variants at a particular point in time. That is to say, even when work of this type looks at diachronic change, it is usually

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focused on change in the aggregate distribution of linguistic forms across different generations.

For a variety of reasons, some of principle and some practical, variationist sociolinguistics mostly puts to the side questions about the dynamics of variation within the speech of individuals, like the one that we have framed in (1):

(1) Dynamics of Variation in Individuals Question (DVIQ): What factors affect whether a given speaker will produce a given variant of a variable in a specific real-time instance of use?

So, for example, it might be the case that two individuals may produce very similar overall proportions of variants A and B of a variable, but the first individual produces the sequence AAAAAABBBBBB while the other produces ABABABABABAB. Although both speakers produce variant A 50% of the time, it may not be accurate to say that the chance of the first individual producing A at any given moment is 50%. The apparent difference would be lost in the traditional variationist approach, which pools tokens across individuals irrespective of which tokens occurred in which order. The temporal-sequential properties of variable observations—by which we mean information about which tokens were produced when, relative to other tokens—are set aside in community-centric approaches to the study of variation but are at the heart of the DVIQ posed here. Our goals in this paper are to synthesize findings showing that there is much to be asked about the dynamics of variation in individuals, and to develop a framework in which this and related questions about how individuals deploy linguistic variants can be investigated systematically.

In the first part of the paper (Section 2), we outline a framework in which an individual speaker's production of variability in any given instance of language use is shaped by three types of conditioning factors: *sociostylistic* ('s-conditioning'), *internal linguistic* ('i-conditioning'), and *psychophysiological* ('p-conditioning'). With respect to the third of these, one of our main lines of argument is that looking at the individual-level dynamics of variation requires a careful examination of general cognitive systems (for example, those related to memory) and psychophysiological systems (like those involved in articulation and perception).

After setting out a general framework, we develop in detail two main points:

(2) Main points to be developed

- **a.** *Point 1:* Token sequences produced by individuals exhibit systematic patterns that are attributable partly to social context and partly to psychophysiological conditioning.
- **b.** *Point 2:* Psychophysiological conditioning factors and internal linguistic conditioning factors are architecturally distinct.

Point 1, developed in Section 3, consists of the claim that there are indeed important things to be explained about how variation emerges from individual speakers in real time. We argue in a review and synthesis of prior literature that there are systematic quantitative patterns displayed in sequences of variants produced by particular individuals, and that aspects of

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these patterns can be explained in terms of what we have called p-conditioning above. When generalized, the results of this section comprise a research program on variation in language in which the individual must play a central role.

Point 2, which is elaborated in Section 4, addresses a specific question about how two types of conditioning relate to each other, in ways that implicate questions about how language is connected with other cognitive systems. First, we posit that p-conditioning and i-conditioning are subject to different types of contextual restrictions, with i-conditioning being constrained by the same locality demands as categorical grammatical alternations and p-conditioning operating over different, potentially larger, domains. This argument suggests that i-conditioning and p-conditioning are architecturally distinct. Second, we suggest that p-conditioning effects are expected to be more or less invariant across communities (due to the way in which they derive from language-external systems such as memory), whereas i-conditioning is at least potentially arbitrary, so that a given individual must learn the effects that an i-conditioning factor has in their speech community. Separating i-conditioning and p-conditioning in the way that we propose has implications for the often discussed distinction between grammar and language use, a point that is addressed at the end of Section 4.

Section 5 offers general conclusions.

2 Three types of conditioning factors

The primary focus of variationist sociolinguistics is the quantitative correlation of a set of linguistic variants with various independent factors, termed “constraints” in early literature. That any given linguistic variable is typically sensitive to a range of distinct predictors is well known; Bayley (2013, 86) terms this the “principle of multiple causes.” These multiple factors are traditionally categorized into two groups: one called “extralinguistic” or “external,” which comprises what Cedergren & Sankoff (1974, 333) describe as “non-language factors such as age, class, and social context,” and the other referred to as “internal linguistic,” reflecting “elements of the linguistic environment” (Labov, 1969; Weinreich et al., 1968). The late 1980s saw a period of intensive inquiry into the basis of this dichotomy, particularly the different developmental profiles of internal and external conditioning patterns (Labov, 1989) and the hypothesized susceptibility of external but not internal factors to interactions (Fasold, 1991). While these particular questions have largely fallen out of focus more recently, general questions concerning the relative roles of internal and external factors in driving language change continue to be explored (Farrar & Jones, 2002; Torgerson & Kerswill, 2004; King et al., 2011). Overall, the binary separation between social and linguistic factors remains a major organizing principle of sociolinguistic theory, as evidenced by recent general overviews of the variationist paradigm (e.g., Bayley, 2013).

Looking at the dynamics of variation in individuals prompts us to expand the typology of influences on variation. In particular, it becomes necessary to distinguish *three* types of factors that may condition variation, as follows:

(3) Factors that influence variation at the individual level

a. Sociostylistic factors, the effects of which we term *s-conditioning*

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b. Internal linguistic factors, *i-conditioning*

c. Physiological and psycholinguistic factors, *p-conditioning*

Our s-conditioning and i-conditioning correspond in some ways to the external and internal factors discussed above (although see Section 2.1 below, where we motivate an internal division of s-conditioning). What we call p-conditioning factors arise from cognitive and physiological systems that are shared by all humans, like working memory capacity, articulatory pressures arising from the physiology of the speech apparatus, resting activation levels for words (of the type that are implicated in priming), and so on. While p-conditioning factors are typically discounted when a community profile is at issue, Point 1 of our paper is to show that these factors figure crucially in determining the dynamics of variation: i.e., that p-conditioning gives rise to systematic quantitative patterns of sequences of variants produced by individuals in real time.[1]

After motivating the study of variation in individuals in Section 3, we move to Point 2, which initiates the search for empirical differences between i-conditioning, s-conditioning, and p-conditioning. We are actively investigating the idea that the three types of conditioning factors are *distinct* in source and in cognitive instantiation, a point which we discuss further in Section 4.2 with respect to i-conditioning and p-conditioning. Though there is no question that they frequently act together to shape a speaker's output distribution of linguistic variants (Bayley's "principle of multiple causes" again), we believe that treating the factors in (3) as distinct is important in ways that are elaborated in the pages to come.

In order to frame the main arguments in Sections 3 and 4, we look briefly at the three types of conditioning in the following subsections.

2.1 s-Conditioning

Sociostylistic effects on variation are probably the best known of the three types of conditioning factors identified here. However, when the dynamics of individual variation are considered, it is important to make a distinction between *static* and *dynamic* components of s-conditioning. *Static* s-conditioning refers to the demographic categories or social group memberships with which variants may covary (e.g. age, sex, social class). Many of the current methods used in the variationist program characterize a group of people with respect to their collective rate of use of some variable: their socially-determined *baseline values*. In the discussion to come, it will be assumed that any particular speaker has a baseline value for each variable of their language, and that the baseline value is derived from static s-conditioning in the familiar way. Beyond this, though, we set this type of conditioning aside in our discussion below, as our primary focus in this paper is on variation at the level of the individual (see in particular Section 3.1), and this type of conditioning naturally requires abstracting over individuals to identify group-level patterns.

[1]S-conditioning— in particular, the effects of style— can of course also structure sequences of variables discussed by individuals. Although s-conditioning is not a primary focus of this paper, several points concerning s-conditioning and its relation to our overall framework are addressed as the discussion unfolds.

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In addition to covering baseline issues, s-conditioning also comprises a class of intraspeaker properties of variation, sometimes treated under the banner of 'style' but here termed *dynamic* s-conditioning. (With this terminological choice we aim to sidestep debates about competing sociological or anthropological explanations for stylistic variation.) This type of s-conditioning is particularly important for the DVIQ, because different styles deployed by the same individual will have an effect on their probability of producing certain variants. That is to say, dynamic s-conditioning is viewed as a set of socially-motivated or discourse-related changes that affect a speaker's target rate for a variable in real time. In simplified terms, we might expect a given speaker to have an implicit goal of producing a colloquial variant at a high rate in a casual situation and a low rate in a situation requiring formality. Dynamic s-conditioning, then, is a cover term for externally-motivated deflections from a socially-established baseline that may arise from the influence of any number of contextual factors.

2.2 i-Conditioning

I-conditioning refers to the effects that elements of linguistic representation in the environment surrounding and containing an instance of a variable can have on that variable's realization. The types of representation in question can differ depending on the particular variable: some alternations have phonological conditioning factors, some have morphological conditioning factors, others might be sensitive to syntactic context, and so on. Moreover, for some variables, sensitivity can be to more than one type of representation, as we discuss in Section 4.2 below.

I-conditioning factors are in many cases the common internal linguistic factors considered in classic sociolinguistic studies. So, for example, we categorize as i-conditioning those factors that implicate the morphological makeup of the word containing the varying element, such as the differential sensitivity of coronal stop deletion to monomorphemes versus past tense forms (Guy, 1980), or the effect on [ɪŋ]~[ɪn] variation of the morphological structure of the word containing *-ing* (an effect identified by Houston (1985) and most recently refined in Tamminga, 2014). Positional constraints on variation also fall under the umbrella of i-conditioning, such as the differential rates of fronting of /θ/ in Glasgow and other communities depending on whether the fricative is word-initial or word-final (Clark & Trousdale, 2009; Stuart-Smith et al., 2013).

2.3 p-Conditioning

P-conditioning comprises the effects of a range of physiological and psychological factors that govern a speaker's language production in real time.[2] P-conditioning can be further divided into two types: physical and cognitive.

Physical p-conditioning has long been recognized in research into speech perception as contributing to what is known as the "lack of invariance problem": the lack of a simple and direct mapping between phonetic categories and the acoustic patterns that physically

[2]For reasons related to the Dynamics of Variation in Individuals Question stated in (1), we focus on production; an equally important set of questions concerns the effects of *perceptual* factors on variation.

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instantiate them (Liberman et al., 1967). Though this lack of invariance stems ultimately from a range of differences between individuals, speech is naturally variable even within individuals, due to what Hoole et al. (1993, 237) describe as "universal neurological and biomechanical constraints of the speech motor system." Factors such as coarticulation and breathing patterns can be included under this type of p-conditioning.

One of the major claims that we aim to develop is that a number of p-conditioning factors above and beyond these low-level physiological constraints affect the dynamics of variation: this *cognitive* type of p-conditioning involves the universal properties of the human mind/brain. Among the factors that we suggest should be included in this category are working memory, production planning, priming, and automatic imitation. Section 3.1 examines a range of these factors, and discusses how they structure the way in which individuals produce variants.

Although p-conditioning can be observed in aggregate data under the right analysis (see, for example, our discussion of auxiliary contraction in Sections 3.1 and 4.2), these factors are manifested in the behavior of individual humans using language in real time, and as such are seen when the behavior of individual speakers is examined. We suspect that p-conditioning factors are pervasive and potentially involved in most if not all cases of variation. There is also reason to believe that they may be quite strong. Take, for example, the variation between [ɪn] and [ɪŋ] for the verbal *-ing* suffix. In Philadelphia English a shift from careful to casual speech in an interview is accompanied by a shift from around 15% [ɪn] to around 35% [ɪn] (Labov, 2001). By way of contrast, the immediately previous variant choice (the p-conditioning factor of *priming*) has a much larger impact for the same variable in the same speech community: when two tokens of the variable are within a few seconds of each other, the difference in variant choice for the second token triggered by the variant in the first token can be as large as 25% [ɪn] after [ɪŋ] versus 85% [ɪn] after [ɪn] (Tamminga, 2014). Although the stylistic range of the interviews from which this data was drawn is far from maximal, we see that not only is the size of the difference elicited by priming detectable, it is in fact sizable in comparison to better-known conditioning factors. Of course, not all p-conditioning effects are expected to be this strong. For example, with an-other well-known variable, the deletion of word-final coronal stops in consonant clusters, a priming effect arises only under a narrow set of conditions: when the stop in question represents a past tense suffix or when a lexical item is repeated (Tamminga, 2014). Our view is that understanding such p-conditioning effects (and how they apply to different variables) should be a basic goal in a theory of the dynamics of variation.[3]

2.4 On the division of conditioning factors

Having now outlined three types of factors that condition variation, a brief discussion of Point 2, concerning the factors' architectural distinctness, is in order.

In principle, both i-conditioning and p-conditioning look as if they can involve reference to linguistic objects in the context of the variable in question. For instance, when a particular

[3]An additional question is whether p-conditioning effects might lead to mistaken attribution of the variation from this source to social, stylistic, or linguistic factors.

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instance of the *-ing* suffix is affected by the choice made earlier between [ɪŋ] and [ɪn] (the p-conditioning factor of *priming*), there is a sense in which a linguistic object in the context is affecting the probability that one variant will be selected. Superficially, this is the same as saying that, e.g., coronal stop deletion rate is affected by morphological information (an i-conditioning factor). However, as we will discuss in depth in Section 4, it is sometimes possible to adduce both grammatical arguments and quantitative arguments to show that a particular instance of conditioning is in fact p-conditioning rather than i-conditioning.

Though separating p-conditioning from other types of conditioning is not unprecedented in the literature on variation (see Labov, 1979 and the more recent Preston, 2004),[4] previous work has typically not differentiated the three types of conditioning factors in the way that we have here. Some researchers, for instance, have proposed treating our i-conditioning as derivative from p-conditioning factors, among them Kiparsky (1972) and Slevc (2011). Conversely, but in a similar vein, factors that we would ascribe to p-conditioning are sometimes implicitly treated as being part of i-conditioning by virtue of their apparently non-social nature (e.g. early discussions of priming (Poplack, 1980, 1984)). More recently, some usage-based models of language make no apparent architectural distinction between our three types of conditioning factors at all, treating all contextual and sociostylistic conditions on variant use as represented in the same way (e.g. as tags on lexical exemplars, as in the implementation of (Hay & Bresnan, 2006)). Although we will not attempt to make a point-by-point comparison with these and other alternatives, we return to the architectural implications of our three-way distinction between conditioning factors in Section 4.3.

In practice, the dividing line between p-conditioning and i-conditioning, and between p-conditioning and s-conditioning, will not always be *prima facie* obvious from a superficial observation of the facts: the question of which factor(s) determine the properties of any given variable is an empirical one, as we will illustrate in Section 4. First, however, it must be established that there is structure to the sequences of variants produced by individuals in the first place. This is the topic of the next section, which explores this point with a focus on p-conditioning.

3 Point 1: Quantitative patterns in variable sequences

It is useful to frame the study of individual dynamics with reference to the speech community. A speech community has historically been defined (at least within variationist sociolinguistics) as a group of people who share the same constraints on, and social evaluation of, intraspeaker variation (Labov, 2006 [1966]). Such constraints, because they are by definition common to members of the group, are often discussed as if they are a property of the group itself, recalling the “grammars of the speech community” at the center of the foundational Weinreich et al. 1968. Guy’s point that coronal stop deletion is “uniformly compelling on all speakers” (1980, 34) exemplifies the justification for what we might call the community grammar view. But since utterances are produced by human individuals, not communities, the constraints on variation must inhere in the mental

[4]Note also the division of Labov’s seminal *Principles of Linguistic Change* trilogy into volumes on Internal, Social, and Cognitive factors; however, ‘cognitive’ in that case refers to the human capacity to perceive and reproduce cultural patterns.

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representations of individual speakers, and the fact that those speakers all share the same constraints is a product of our definition of a speech community. The study of what is shared by all group members, in other words, is strictly speaking the study of a recurring property of individuals, despite the fact that the conventional terms for such analysis suggest a community-level phenomenon.[5]

Our Point 1 is that there are structured quantitative patterns in the production of variants by individual speakers: patterns in the sequences of variants as they are produced by speakers in real time. As mentioned in Section 2, the temporal-sequential properties of variants are set aside in the traditional variationist methodology. The practice of dissociating variable observations from the order in which they were produced is rooted in claims such as the following (Labov, 2006 [1966], 77, emphasis added):

> Here are the occurrences of (th) in casual speech, in the order that they occurred: 1 2 2 1 2 2 1 1 1 1; and here are the occurrences in careful speech: 2 2 1 1 1 1 1 1 1 1 1 1 1 1 2 1 2 1. **There seems to be no pattern or system within this sequence** – yet it fits into the larger pattern shown in the array of styles.

While Labov here acknowledges that some stretches of speech are different than others by virtue of style-shifting, he does not pursue the possibility that there is further systematicity within the careful and casual sequences that is derivative of other sources. In other words, the standard view is that once we have delineated stylistically-distinct sections of speech, what remains within each section is stochastic variation (albeit constrained by linguistic factors in a way that can be observed once all tokens are pooled).

In the remainder of this section we will synthesize findings that show that the order and timing in which variant tokens occur are not fully random, in ways that implicate p-conditioning in particular (Section 3.1). We will then outline some further questions concerning sequences of variants, and situate the investigation of individual dynamics with respect to directions for future research (Section 3.2).

3.1 P-conditioning as a source of individual dynamics

It is relatively easy to imagine how dynamic s-conditioning, as described in Section 2, could play a role in giving rise to quantitative patterns of individual dynamics, even if questions about how to incorporate style and related notions into the cognitive architecture of language continue to be actively discussed. On the other hand, the influence of p-conditioning factors, especially cognitive ones, has received much less attention in the study of variation. In this section we review and synthesize evidence concerning the role of p-conditioning.

In Section 2.3 above, we briefly outlined the nature of p-conditioning factors. In that initial discussion, we distinguished *physical p-conditioning* from *cognitive p-conditioning*. Under the former, we have in mind the effects of physiological constraints on speech production. For example, a major source of intra-speaker phonetic variability is coarticulation, the

[5]How the same set of constraints is learned by many individuals is a separate, though certainly relevant, question; we reject the premise of Labov (2012) that the existence of the individual as an important level of linguistic analysis is isomorphic to the question of the target of acquisition.

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overlap and interaction between articulators in the real-time production of speech (see Farnetani & Recasens, 2010 for an overview). Coarticulation has been proposed as the source of gradient patterns of assimilation such as the palatalization of /s/ before a following /j/ (Zsiga, 2000) and the absence of an alveolar gesture in instances of /n/ before /k/ (Ellis & Hardcastle, 2002). Though there is evidence that coarticulation can show language-specific effects (e.g. Manuel, 1990), these differences constitute cross-linguistic variation in the degree of coarticulation, not its absolute presence, which is thought to be universal (Farnetani & Recasens, 2010). Another source of variability in speech production within the individual is breathing patterns: respiratory function has been found to be influenced by cognitive load, audiovisual stimulation, conversational turn taking, and a speaker's emotional state (McFarland, 2001), and breathing is in turn connected to features of speech including pitch contours across breath groups (Kutik et al., 1983), pause prevalence (Zellner, 1994), and voice onset time (Hoit et al., 1993). Low-level, physical p-conditioning factors always play a role in speech production,[6] and thus must be part of the investigation of individual dynamics.

For present purposes, however, we are more interested in the effects of cognitive p-conditioning on variation. In the rest of this section, we review several cognitive p-conditioning factors, and expand on their relationship with the production of variation in individuals. We begin with a discussion of factors shown to affect variation in recent work, namely production planning and priming, then turn to the factors that we believe should be considered in future investigations.

Planning—One cognitive system affecting language production in ways that are important for variation is the planning of utterances (see Allum & Wheeldon (2007) for an overview). There is good reason to believe that the planning of units "downstream" occurs simultaneously with the production of earlier units (Levelt, 1989), and the degree and extent of downstream planning can affect a number of features of those units that are being articulated. Among these features are a unit's likelihood to be followed by a pause and to contain a disfluency, both of which are more likely the more complex the upcoming unit being planned (Clark & Wasow, 1998; Ferreira, 1991).

A speaker's ability to plan a given utterance may be modulated in certain experimental settings, and this, too, can affect her language production. For example, Tilsen (2012) demonstrates that speakers shift a clashing primary stress in accordance with the Rhythm Rule (changing, say, the phrase *Japanése géckos* to *Jápanese géckos*) only in prepared, but not in unprepared speech, where (informally) constraints imposed by the planning system preclude the execution of the prosodic alternation. That planning constraints can produce such an alternation suggests that they may also influence already-variable phenomena in ways that have only begun to be explored.

In most cases, the variationist approach implicitly assumes that all relevant conditioning information is equally present and operative on each instance of the variable (though see

[6]In addition, some types of conditioning are not exclusively "low-level", despite being prima facie physical p-conditioning. For instance, Scarborough (2013) reports that degree of coarticulation interacts with neighborhood density/frequency, indicating that the "low-level" effect interacts with what we could call a cognitive p-conditioning system.

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Guy (1991a) for a counterexample). But when we consider the dynamics of variation in individuals, it can be seen that this assumption is not uniformly valid. Regarding planning, a possibility is that contextual factors and the variables that they affect are not always present in the same planning buffer. Planning is thus important to variation because the planning system will determine whether or not an instance of a variable and its potential contextual influencer are able to interact with each other. For example, MacKenzie (2012) attributes subject length effects on auxiliary contraction to the possibility that the auxiliary is not always planned in the same buffer as the subject if the subject is long. In Wagner (2011, 2012), data from an experimental production task show that the strength of the prosodic boundary preceding an upcoming clause, a metric taken to indicate whether that clause is likely to have been planned at the time the boundary is reached, affects the conditioning of the [ɪŋ]~[ɪn] alternation. The argument is that when a following constituent has been planned, its phonology is available to condition [ɪŋ]~[ɪn] choice, with more [ɪŋ] surfacing before a following vowel and more [ɪn] before a following consonant. When the following constituent has not been planned, though, this regressive phonological conditioning cannot operate, and the distribution of variants changes. A number of recent papers have shown that the basic prediction made by this analysis—that variable conditioning by elements across word boundaries is sensitive to planning likelihood—hold in conversational speech corpus data as well (Tamminga, 2015; Tanner et al., 2015), although the facts may differ for phonological and morphosyntactic variation (MacKenzie, 2015b).

The DVIQ asks what factors affect the outcome for a variable in an actual instance of use in real time; the discussion here shows that the production of variation is affected by what is being planned at the moment of that instance of use. Constraints on production planning may cause the choice of a variant to be deferred too late to affect a left-leaning process like contraction, or they may make elements of the context following a variable element unavailable at the time variant choice occurs. Limits on cognitive capacity thus illustrate another way in which individuals must figure prominently in the study of variation. Constraints on variability which seem arbitrary when viewed at the community level may in fact be a reflection of individual-level cognitive constraints. For instance, the finding from MacKenzie (2012) that contraction is unattested in spoken English after subjects longer than eight words may be related to the generally-accepted limits on working memory capacity, which center around seven items across individuals (Miller, 1956).

We return to the topic of interactions between conditioning factors with a more detailed example of production planning effects in Section 4.2.

Priming—Another cognitive p-conditioning factor that intervenes in the production of variation is priming. With respect to lexical items, priming (shorthand for *priming facilitation*) refers to speeded lexical access after prior exposure. The seemingly related phenomenon of structural priming is a preference for using a recently-processed syntactic structure to form a novel utterance in cases with multiple syntactic options available, whether in an experimental setting (Bock, 1986; Pickering & Ferreira, 2008) or conversational speech (Weiner & Labov, 1983; Gries, 2005; Szmrecsanyi, 2006). In the context of sociolinguistic variation, priming is generally thought of as an increase in the tendency towards one variant or another after previous processing. For example, as

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mentioned above, speakers who have recently used the [ɪn] variant of the variable [ɪŋ]~[ɪn] alternation are significantly more likely to reuse [ɪn] in the next instance than if they had recently used [ɪŋ] (Abramowicz, 2007; Tamminga, 2014).

Since this phenomenon was first identified in conversational speech (Sankoff & Laberge, 1978; Poplack, 1980; Weiner & Labov, 1983), sociolinguists and corpus linguists have identified priming in a wide range of variables, across different languages and different linguistic levels (see *inter alia* Scherre & Naro (1991); Cameron (1992); Scherre (2001); Cameron & Flores-Ferrán (2004); Szmrecsanyi (2006); Abramowicz (2007); Travis (2007); Tamminga (2014); Clark & Walsh (2014)). The identification of priming as a relevant factor in linguistic variation is thus far from new. It is also not novel to point to a cognitive basis for repetitiveness in variant choice; Scherre (2001), Cameron & Flores-Ferrán (2004) and Szmrecsanyi (2006) all explicitly tie their corpus results to psychological models of priming. However, the notion that priming is a distinct *type* of conditioning factor has not been fully developed in sociolinguistic theory. Crucially, sustained influence from previously–produced or –perceived tokens is not static, and requires reference to the recent experiences of the individual speaker in real time. The study of priming thus requires reference to temporal sequences of variants in a way that is not properly captured by the notion of a community grammar. It is our view that the full architectural and quantitative implications of this point have not been realized or explored.

Furthermore, Tamminga (2014) suggests that repetitiveness in variation, previously conceptualized straightforwardly as a reflex of “priming,” is not a single effect but instead may involve multiple underlying facilitatory cognitive mechanisms interacting with variables at different levels of the grammar. She finds that priming effects have different degrees of generality, and different patterns of temporal decay, in phonological and morphological variables, and attributes the differences to a distinction between activation of abstract lexical items and episodic memory for surface properties of words. Each of these layers of complexity adds a dimension to be explored in the dynamics of individual variation.

The progress made in recent studies of how planning and production affect variation motivate us to suggest other cognitive p-conditioning factors that might be considered in future research. While the following paragraphs highlight the potential that studies of imitation and working memory effects hold for understanding the dynamics of variation in individuals, this is far from a comprehensive listing of the set of cognitive p-conditioning factors that might be pursued in future work.

Imitation—Another potential source of variation in the dynamics of speech is imitation. A number of studies have shown that speakers imitate details of the speech of their interlocutors; see Zellou et al. (2016) for a recent review of relevant literature. Current theories of the cognitive mechanisms responsible for imitation posit (at least) two distinct (but not mutually exclusive) sources for such effects: one is social in nature (see e.g. Namy et al. (2002); Pardo (2006); Pardo et al. (2012, 2013); Babel (2012)) the other is more bottom-up and mechanical, reflecting either a perception–production loop (e.g. Pierrehumbert (2002); German et al. (2013)) or a type of priming (e.g. Pickering & Garrod

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(2004)). Current work in this area is examining exactly what aspects of interlocutors' speech are imitated, with uncertainty remaining around key questions about what is imitated, how fine-grained imitation is, and how long imitation effects last. These questions notwithstanding, automatic imitation (i.e. the non-social type) represents another important source of potential p-conditioning, as it means that the realization of any given token of a variable in real time depends on recently processed tokens in a way that can be conceptualized only at the level of an individual speaker.

Working memory—The final cognitive p-conditioning factor that we consider here is limitations on working memory, the system implicated in the processing and temporary storage of verbal material (Baddeley, 1986). A number of converging lines of research have demonstrated that a speaker's working memory capacity affects their language production. For instance, speakers with shorter memory spans (assessed by the number of items which they can remember in a controlled task) are more likely to produce "slip of the tongue" speech errors (Daneman, 1991; Saito & Baddeley, 2004) and subject-verb agreement errors (Hartsuiker & Barkhuysen, 2006) in experimental settings designed to elicit them. Their speech in open-ended production tasks consists of fewer words per minute and is less semantically rich and grammatically complex than that of speakers with longer memory spans (Daneman, 1991; Kemper & Sumner, 2001). These correlations extend beyond cross-speaker differences to the intra-speaker level: when a subject's working memory is taxed (e.g. by a requirement to hold in memory a series of digits or words, or when asked to perform a concurrent task such as walking or finger tapping), they produce less semantically rich and grammatically complex utterances than when speaking without a cognitive load (Kemper et al., 2003; Power, 1985).

Absolute and speaker-specific limits on memory, as well as fluctuations in an individual's available memory capacity over time, may influence variation by limiting the degree to which variables may be sensitive to prior sequences of variants or other contextual factors. Insofar as producing variation entails tracking information across stretches of speech, quantitative patterns of variation may be affected by interspeaker differences or intraspeaker fluctuations in working memory capacity. Memory constraints may interact with the imitation effects so pervasive to the general process of language production; socially-mediated accommodation between two conversational partners, for example, requires crucially that each partner retain a memory of not just what the other speaker has said but how they said it. The level of detail that can be stored in this respect, and how long it can be stored for, has a direct impact on the amount of accommodation possible and may be based at least partially in memory capacity.

To be quite clear, this discussion does not attribute variability to speech error; we maintain a sharp distinction between systematic inherent variability and speech errors. Rather, we suggest that memory constraints (as discussed in the speech error literature) may interact with other constraints in the systematic production of variation.

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3.2 Degree of dynamism and microcovariation

We have seen above the role that p-conditioning can play in affecting the outcome of variation when it is considered in real time. This perspective directs our attention to the temporal-sequential properties of variation. Many of the effects of p-conditioning extend across distances longer than the span of grammatical locality, meaning that the evidence for them is embedded in longer sequences of variants. As the questions that arise from the DVIQ become more complex, we will need to turn away from looking at isolated tokens and find new ways of describing and analyzing the properties of these longer sequences. In other words, we expect sequences of variable tokens to show patterns that are related to the operation of p-conditioning factors. To illustrate, we outline two simple dimensions along which we might expect to find differences between individuals in the temporal properties of the sequences of variants they produce.

The first dimension is *degree of dynamism*: the idea that even two speakers with an identical mean for a given variable might arrive at that mean through a wide or narrow distribution of tendencies and choices over time. Tamminga (2014) illustrates an effect of this type through a brief comparison of several speakers' real-time production of [ɪŋ]~[ɪn] alternation, coronal stop deletion, and [ð]-stopping. The data are taken from the Philadelphia Neighborhood Corpus (Labov et al., 2011), a collection of transcribed and forced-aligned sociolinguistic interviews with English speakers from Philadelphia. Figure 1, adapted from Tamminga (2014), presents rolling averages (with a window equal to 1/20 of the number of tokens, with approximately equal numbers of tokens across both interviews) of coronal stop deletion for two different individuals. Both speakers have an overall mean deletion rate close to 50%. The individual in the top panel, though, arrives at that mean by averaging over sections of very high and very low deletion, whereas the individual in the bottom panel arrives at the same average after clinging quite closely to the 50% mark for most of the interview. This pattern suggests that—despite their identical means—there is something different about how coronal stop deletion is implemented by these two speakers.

A central component of individual speaker dynamics is of course dynamic s-conditioning. The most obvious interpretation of high dynamism in a stretch of speech is that the speaker was moving across different styles evoked by shifts in topic or interlocutor. Even so, there may well be individual differences in the degree to which different individuals respond to contextual shifts, with some speakers having a wider range of stylistic variability than others. It is is unlikely that dynamism is fully reducible to s-conditioning, as dynamic s-conditioning will likely co-occur with (or even induce) changes in p-conditioning factors that may themselves constrain variability above and beyond the effects of style. For example, inter-speaker differences in dynamism may reflect individual differences in the degree of facilitation from priming or the speed at which priming effects decay.

Modern sociolinguistic views of style in many cases highlight the shifting ways that variants of different variables can cluster together to produce stylistic performances in specific moments or interactions (Eckert, 2012). In keeping with this emphasis on multiple variables at once, the second dimension of individual-level dynamics of variation that we consider here is *microcovariation*: the different temporal co-occurrence patterns of variant instances across variables, independent of their dynamism profiles. Figure 2, again taken from

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Tamminga (2014), illustrates that temporal co-occurrence patterns can differ in this way. For the individual in the top panel, coronal stop deletion and [ð]-stopping track each other closely, moving up and down in tandem. In contrast, the individual in the bottom panel shows exactly the opposite pattern for most of the interview, with coronal stop deletion and [ð]-stopping appearing to be almost repelled by each other. The degree to which the patterns here should be attributed to s-conditioning or p-conditioning is, as with the dynamism patterns above, a question which will certainly have a complex answer. Careful attention must to be paid to the analytical and quantitative task of disentangling dynamic s-conditioning from the more mechanical dynamic properties of p-conditioning. An important direction of research will involve connecting the framework outlined in this paper with recent and continuing methodological advances in the quantification of style shifting (Podesva, 2007; Sharma & Rampton, 2011; Ginsberg, 2012; Ahern et al., 2015).[7]

3.3 Summary

In this section we have examined a range of factors that are set aside in traditional variationist analysis. These factors affect the outcome of variation when we consider the production of variation by individuals in real time, which is, we argue structured in ways that deserve systematic investigation. Our main focus in this section is on what we stand to gain by viewing such patterns in terms of p-conditioning. As we discussed, production planning can interact with i-conditioning by disrupting the presence of elements of the linguistic context in real time. Priming can reflect repetition of variants used by the same or a different speaker several utterances earlier. Automatic imitation necessarily makes reference to a connection between what a speaker perceives and what they subsequently produce. A speaker's working memory capacity may limit the temporal span over which accommodation effects can take hold. Such factors do not fit naturally into a perspective where the speech community is the unit of analysis, because they tie instances of a variable to longer sequential contexts reflecting the psychological state of an individual. As the evidence for the influence of these and other p-conditioning factors accumulates, the need to take an individual-level perspective will become more apparent.

The traditional community grammar perspective against which we situate this need has both a methodological and a conceptual component. Methodologically, for as long as sociolinguists' standard statistical tool was what we now call fixed-effects regression, the only options for investigating individual-level patterns statistically were to include individual identity as a predictor (with an unreasonably large number of values), or to fit a separate regression to each individual's data, and thus lose the generalizations about what conditioning patterns individuals do in fact share. The increasingly widespread adoption of mixed-effects hierarchical regression modeling has largely rendered this problem obsolete. The inclusion of by-speaker random intercepts in regression models compensates statistically for different rates of variant use across speakers, and allows for the intercepts to be extracted for further examination (Drager & Hay, 2012).

[7]A related and important topic, which is already attracting careful attention from other directions (Campbell-Kibler, 2010; Babel, 2012; Squires, 2013), is how the interface between variable production and social meaning is mediated by social cognition.

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In line with this shift in statistical practice, sociolinguists have recently begun to investigate the distribution of individual means within groups, asking for example whether speakers' means correlate across variables (Hazen, 2013; Oushiro & Guy, 2015). Although our research agenda extends beyond questions about individual means, sequential properties such as dynamism and microcovariation deal with deflections away from some putative abstract baseline rate that needs to be calculated and discussed. Doing so may in turn open new avenues of inquiry relevant to the DVIQ. As one example, Tamminga (2014) asks whether priming might differ across individuals as a function of their own baselines due to the known sensitivity of priming to rare occurrences (see Jaeger & Snider (2013), who analyze this effect by calculating *surprisal*, an information-theoretic measure of unexpectedness, over linguistic contexts). So, for a speaker from a working class background who produces primarily [ɪn] it may be the case that [ɪŋ] is the unexpected variant that elicits a strong surprisal-based priming effect, despite the global status of [ɪŋ] as the standard variant. When we focus on the DVIQ, we will also encounter a new set of quantitative problems, such as normalization of variable occurrence rates across individuals and over time. Novel applications of existing statistical tools, such as the use of Generalized Additive Models with time splines to simultaneously estimate independent effects of dynamic s-conditioning and priming (Ahern et al., 2015), hold promise for the methodological integration of speaker-level and community-level perspectives.

As mentioned above, the traditional view is not merely methodological, however; Labov has called it "the central dogma of sociolinguistics that the community is conceptually and analytically prior to the individual" (2012, 266) and asserted that "the individual does not exist as a unit of linguistic analysis" (2014, 18). While we do not dispute the importance of the speech community in sociolinguistics, we note that this dogma is related directly to the explanatory goals that it is associated with. Variation can be studied in more than one way; if one's goals are to explain how variation is manifested along different social dimensions, then of course the group is going to be of central interest. On the other hand, variation can also be studied in real time, and in individuals, in ways that will be informed by—and ultimately inform—the community-based perspective. Our comments in this section present a preliminary argument that individuals not only exist, sociolinguistically speaking, but also must be taken into account as the source of the p-conditioning factors that are of central interest in a theory addressing the DVIQ.

In the next section, we consider the architectural implications of distinguishing individual behavior from community level patterns, through an argument for treating p-conditioning as qualitatively different from i-conditioning.

4 Point 2: p- and i-conditioning are architecturally distinct

In this section we take a closer look at some of the properties of individual speakers that shape variable outcomes. The argument involves two main components. The first point (Section 4.1) is that variable and categorial alternations show asymmetries in how they are conditioned, and that accounting for these asymmetries is straightforward in a theory in which i-conditioning and p-conditioning are architecturally distinct. The second point (Section 4.2) is that p-conditioning is universal, whereas i-conditioning is potentially

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arbitrary; this is a further argument for distinguishing p- and i-conditioning. In Section 4.3 the more general implications of this argument are examined, with respect to the idea that grammar and use are distinct.

4.1 Asymmetrical conditioning of alternations

The proposal that p-conditioning and i-conditioning are distinct is suggested by an asymmetry in how conditioning factors interact with different types of linguistic alternations. We use the word "alternation" broadly here, to capture any instance in which a single underlying linguistic element can be realized in more than one way. Alternations can be categorical (i.e., invariant), as exemplified in (4), or variable, as exemplified in (5). As we will show below, categorical alternations and variable alternations can be conditioned in different ways, and it is this asymmetry in conditioning that lends support to a separation between p-conditioning and i-conditioning.

(4) Examples of categorical alternations

- **a.** Phonological: In many varieties of American English, /æ/ is realized differently in front of nasals (*hand*) than in front of other consonants (*happened*) (Labov et al., 2006).
- **b.** Morphophonological: The final segment of *plastic*, realized as /k/ in that form, surfaces as /s/ in front of *-ity* (*plastic-ity*). (But not in front of e.g. *-esque* in *plastic-esque*, or *-y* in *plastic(k)-y*.)[8]
- **c.** Morphological: The past tense morpheme is realized as /d/ in *play-ed* (and all other "regular" verbs), but as /t/ in the context of *bend*, *leave*, and some other verbs.
- **d.** Morphosyntactic: The first person pronominal is realized as *I* in one set of contexts (to oversimplify, "nominative"), and *me* in others.

(5) Examples of variable alternations

- **a.** Phonological: Coronal stops are sometimes deleted and sometimes retained in word-final consonant clusters (e.g. *mis'* ~ *mist*).
- **b.** Morphophonological: The final segment of *path* is sometimes voiced next to the plural marker /-z/ (*paθ-z*), sometimes not, triggering assimilation of the plural suffix (*paθ-s*) (MacKenzie, 2015a).
- **c.** Morphological: The realization of the past tense morpheme varies for e.g. the verb *burn* (*burn-t* ~ *burn-ed*); the realization of the participle morpheme varies for e.g. the verb *show* (*show-n* ~ *show-ed*).
- **d.** Morphosyntactic: Auxiliaries (forms of *be*, *have*, *will*) are sometimes contracted onto the word immediately to their left (*That dog's barking again*), and sometimes realized as full forms (*That dog is barking again*).

[8]This alternation is *morpho*phonological in the sense that /k/ → /s/ is not a general property of English phonology; compare *wake*, *waking*.

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Whether categorical or variable, each of these alternations shows sensitivity to material in its linguistic environment. So, for example, in (4b), the alternation between /k/ and [s] is triggered by the suffix following the /k/; in (4c), the alternation between /d/ and /t/ in the realization of the past tense is triggered by the particular verb the suffix attaches to. In a similar way, variable alternations are sensitive to surrounding linguistic material (as previously outlined in Section 2.2). For example, it has long been known that coronal stop deletion (5a) applies at higher rates in monomorphemes than in contexts where the stop is coterminous with the past tense suffix (Labov et al., 1968); contraction of *is* (5d) applies at a higher rate after a vowel than after a consonant (Labov, 1969); and so on. We unite the contextual sensitivity of categorical alternations and the contextual sensitivity of variable alternations under the heading "conditioning."

It has been recognized (Guy & Boberg, 1997; Bresnan & Nikitina, 2009; Burnett, this volume) that, in many cases, the same factors are at play in the conditioning of both variable and categorical alternations. For instance, Bresnan & Nikitina (2009), discussing the dative alternation in English (e.g. *I gave John the cake ~ I gave the cake to John*), demonstrate an effect of recipient locality, with non-local (third person) recipients favoring prepositional datives compared to local (first and second person) recipients. They then note the presence of a similar, but categorical, effect on dative realization in Kanuri, where non-local person recipients of the verb *give* can be expressed only with a postpositional phrase, while local recipients are expressed via a direct object prefix on the verb. Additional cases in which categorical and variable alternations are conditioned by the same factors are not difficult to find. For instance, variable *is*-contraction in English, which is sensitive to whether the preceding segment is a consonant or a vowel, shares this conditioning with invariant Korean nominative suffix allomorphy, which alternates between /i/ after consonants and /ka/ after vowels (see Paster (2006) and references cited there).

In previous work exploring the extent to which linguistic variation is part of a speaker's grammatical competence, such overlap in conditioning factors plays an important role. For instance, Guy & Boberg (1997) argue that shared conditioning factors between categorical and variable alternations is evidence in favor of treating variable alternations as part of a speaker's linguistic competence, rather than as arising from grammar-external performance phenomena. More specifically, they argue that variable coronal stop deletion, by virtue of being conditioned by the similarity of the coronal stop to the segment that precedes it, demonstrates sensitivity to the same similarity-avoidance effects that condition categorical alternations in the world's languages. Based on considerations of parsimony, they conclude that because categorical grammatical alternations and variable alternations can make reference to the same conditioning factors, they should be handled in the same cognitive system, viz. the grammar.

We will return to Guy and Boberg's claims later in this section. For the moment, we will focus on a different point: there are also cases in which variable alternations are conditioned by factors that **do not** condition categorical alternations. Variable auxiliary contraction in English, for instance, is strongly sensitive to the length of an auxiliary's noun phrase subject, with a gradient decline in likelihood of contraction with every word added to a subject (MacKenzie, 2012). Unlike the preceding-segment constraint on this same alternation,

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however, this conditioning is, to our knowledge, not shared by any categorical alternation: "grammars can't count" (e.g. Selkirk (1986) among others), and categorical alternations are not found to make reference to quantities greater than two. Similarly, the priming effects demonstrated to condition many sociolinguistic variables (see Section 3.1) are unattested in the categorical domain, and in fact violate the locality conditions that appear to apply to invariant grammatical alternations (see Embick 2010a, 2010b, 2013 for morpho(phono)logical proposals that relate to 4–5)).

Based on this observation, our argument is that there are some factors that condition variation that are extragrammatical: that is, factors that condition variable alternations, but never categorical alternations. These types of factors must be represented **outside** of the grammar. To illustrate, a categorical version of the priming effect on variation might be something like this: imagine a language with two suffixal allomorphs for first person singular verb inflection. One allomorph is used after obstruent-final verbs, while the other is triggered by vowel-final verbs. Verbs ending in sonorant consonants, however, invariably take *whichever allomorph was used most recently by the speaker*. We contend that such an alternation, the putative categorical counterpart of [ɪŋ]~[ɪn] priming, does not and could not exist. While interactions across stretches of words are found with priming, they are not attested in categorical instances of allomorphy, for reasons of locality.

Similarly, to our knowledge, there is no invariant version of the subject length effect that conditions contraction: no case of allomorphy where, say, one allomorph surfaces after items of five syllables in length or less, while another surfaces after items of six syllables or longer. Priming and subject length, which operate robustly in the conditioning of variable linguistic alternations, do not operate on the conditioning of invariant ones. For convenience we call such conditioning factors "extragrammatical"; what should be understood by this term is "factors that condition variable but never categorical alternations."

Our proposal is that this asymmetry in conditioning derives from an architecture in which i-conditioning and p-conditioning factors are distinct in kind. Specifically, as we discussed in Section 2.2, i-conditioning is found when an element in a linguistic representation affects the probability that a given variant will be chosen. For this reason, i-conditioned instances of variation lend themselves to analysis in terms of *variable rules* (or related ways of introducing variation into grammars). It is important to observe that variable rules are just rules whose probability of applying is not 1; that is to say, they are possible rules of grammar, and thus in principle could become categorical if their probability increased to 1. I-conditioning, then, is what we often see when a variable alternation is conditioned by the same factors that apply to a categorical one (for the qualification to "often" see below). By contrast, we conjecture that when a variable alternation is conditioned in ways that are not attested in categorical alternations, the conditioning is p-conditioning (or s-conditioning), and not i-conditioning. Now it is clear what is gained by maintaining a sharp distinction between the sources of p- and i-conditioning: not having such a distinction would amount to saying that there is a set of alternations in the grammar that all happen (i) to be variable, and (ii) to not be subject to the locality conditions that apply to invariant alternations. Rather than accept a single system with this kind of unfortunate coincidence, our view attributes the

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conditioning asymmetries to the fact that distinct underlying systems are involved in shaping surface variation.

Analyzing extragrammatical effects as p-conditioning is a first step in understanding a particular case of variation. The next step is to identify the particular type of p-conditioning that is at play: that is, it should be possible to identify a grammar-external cognitive system with properties that fit the effect, e.g., one of the p-conditioning factors discussed in Section 3. So, for example, in the case of English auxiliary contraction, MacKenzie (2012) argues that the effect of subject length may derive from constraints on production planning: specifically, long subjects are planned separately from the verb that follows them (Ferreira, 1991), such that contextual conditions on contraction (namely, host–auxiliary adjacency in a single planning buffer) are not always met. Similarly, in the case of priming, the cognitive basis of repetition in variant choice has been studied extensively (see Section 3.1), even though many questions remain about how priming effects are manifested in variation.

With respect to the scope of the argument outlined to this point, there are three further points to be made.

First, we have spoken above of factors that affect variable but not categorical alternations, and that have their source in p-conditioning, and not in i-conditioning. However, the possibility also exists that such effects could be attributed to s-conditioning. For example, repeated instances of [ɪŋ] could result from a stretch of especially casual speech rather than from priming. It is for this reason that understanding the dynamic component of s-conditioning identified in Section 2.1 is essential for this research program. Ultimately, a comprehensive theory addressing the DVIQ must be able to identify the ways in which p- and s-conditioning interact to produce patterns of variable behavior in real time.

Second, our claim here is based on the idea that extragrammatical p-conditioned alternations are not possible categorical rules of grammar. While in the typical cases we have in mind this results in *variability* that is affected by p-conditioning, it is also true that there are apparently *categorical* effects in the p- domain. For example, the well-studied case of English center embedding (Miller & Chomsky, 1963, etc.) is of this type: after a certain level of embedding, sentences are categorically regarded as deviant (for a more detailed discussion of this effect see Lewis and Phillips (2015) and references cited there). Unlike what we find with e.g. priming, where the p-conditioning effect allows for grammatically non-local interactions, the memory effect implicated in center embedding restrains the use of certain structures derived by the grammar, making them essentially unusable due to memory considerations. For our purposes, what is important is that even though this effect is categorical, it is not a categorical rule of grammar; rather, it is categorical in the way that it is because of the properties of memory.

Finally, the view that we have developed here builds on ideas developed by Guy & Boberg (1997), but ultimately departs from their conclusions. Our primary point is that non-local conditioning is necessarily p-conditioning, and not grammar-internal. Guy and Boberg, on the other hand, argue that identity of conditioning factors for variable and categorical alternations requires the conditioning factors to be treated in a single cognitive system. This

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conclusion does not follow in our framework. Rather, conditions on variable alternations that are also observed in categorical alternations could in principle be i-conditioning **or** p-conditioning.

By way of illustration, consider the conditioning of coronal stop deletion. An unresolved question about this phenomenon is to where to attribute the following segment effect, the very robust observation that deletion is more likely when followed by a consonant-initial word and less likely when followed by a vowel-initial word. One explanation for this fact, which relies on a conceptualization of coronal stop deletion as at least partially a fast speech reduction process (as in e.g. Ernestus (2014)), is that consonant clusters may result in overlap and masking of the multiple closure gestures, whereas CV sequences are more likely to allow for full realization of the consonantal gesture. Alternatively, the following segment effect might be attributed to the abstract phonology, with the preference for CV syllables leading to resyllabification of a word-final coronal stop onto the first syllable of the following word, which in turn might bleed a phonological word-final deletion rule (as in e.g. Guy (1991b)). The following segment is grammatically local to the coronal stop regardless of what view we take on the deletion process. But in the former account, the following segment effect on coronal stop deletion is an example of p-conditioning, while in the latter account it is an example of i-conditioning.

The two explanations in the preceding paragraph are not mutually exclusive; they could both be at work to produce the surface effects of variable coronal stop absence. If there is a phonological coronal stop deletion rule, it is reasonable to expect that the stops that do survive deletion will still be subject to general fast-speech lenition processes, meaning that some absent coronal stops were removed entirely in the phonology while others were eroded to the point of imperceptibility during the online process of speech production. This kind of "deconstruction" of variable alternations has been executed for several phenomena, including coronal stop deletion (Patrick, 1991; Fruehwald, 2012; Tamminga & Fruehwald, 2013; Tamminga, 2014), [ɪŋ]~[ɪn] variation (Labov, 2001; Tagliamonte, 2004; Tamminga, 2014), and auxiliary contraction (MacKenzie, 2013), among others. This work also finds an analog in Bermúdez-Otero's (2013) concept of "rule-scattering."

We will return to the theme of non-exclusivity in the next section, which examines further differences between i-conditioning and p-conditioning.

4.2 Universality and arbitrariness in the p- and i- domains

As discussed in Sections 2 and 3, p-conditioning effects derive from the workings of the (often domain-general) cognitive systems that are involved in language use. In contrast, i-conditioning is hypothesized to be grammar internal. An important consequence of this view is that i-conditioning can be language- or variety-specific, arbitrary, and therefore learned, whereas p-conditioning is expected to be universal and automatic. We expect to find p-conditioning across all similar phenomena in all varieties, exerting a constant or at least predictably-distributed effect on all individuals (although interactions with i- and s-conditioning could complicate this simple picture in practice). Such an expectation does not hold for i-conditioning.

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Coronal stop deletion again offers a familiar example to illustrate these points. We classify as i-conditioning the effect of utterance-finality on deletion probability, which Guy (1980) shows goes in opposite directions in New York and Philadelphia English: an arbitrary difference across varieties that must be learned. Similarly, the observation from Tagliamonte & Temple (2005) that the past tense suffix affects deletion rates only in American English, but not in British English, is evidence that grammatical conditioning of deletion in American English results from i-conditioning.[9] In contrast, fast-speech reduction processes (as discussed in Section 4.1) should be essentially unavoidable without concerted effort; indeed, this intuition was the basis for the suggestion that even stops that survive a phonological deletion process should still be subject to lenition in production.

Cross-dialectal differences do not need to be wholly random to be compatible with an i-conditioning interpretation: it would not be surprising to find typological patterns across varieties in i-conditioning that arise from e.g. p-conditioning tendencies that develop into i-conditioning diachronically. But we would also not be surprised to find exceptions or counterexamples to commonly-attested types of i-conditioning, whereas with p-conditioning such exceptions are not expected.[10]

On the general theme of universal versus language-particular effects, some care must be taken to specify what it means for a conditioning effect to be "universal." One outstanding question where p-conditioning is concerned is the question of how the influence of different cognitive systems found in all humans should be manifested in variable linguistic phenomena. Given that many cognitive systems at issue (e.g. those related to memory) are distributed differently across individuals (Ackerman, 1988), "universal" in this context does not mean completely invariant; rather, it means an individual's p-conditioning effects should fall within an expected distribution. So, for example, we might find that two different individuals show different effect sizes with respect to p-conditioning driven by working memory; the universality is that these two effects would be contained within a range of working memory sizes (Brewer & Unsworth, 2012).

In addition, we have already seen in a number of cases that p-conditioning may interact with other factors. Such interactions may result in apparent non-universality. The interaction of planning with the availability of adjacent i-conditioning elements discussed in Section 3.1 (with reference to English auxiliary contraction) is one such example; so is the possibility raised in Section 3.3 that priming magnitude might vary inversely with speaker baselines. Expanding on the latter point, we also note that other facts that generate social expectations, such as changes to the participants in a conversation or the physical situation of that conversation, might likewise evince surprisal-based priming modulations: an interaction between s-conditioning and p-conditioning. Thus, while priming effects may very well be "universal" (i.e., driven by mechanisms that are present in all language users), they may nonetheless vary dynamically with situational factors in ways that are now beginning to be explored quantitatively. This poses not just the problem of quantitatively disentangling two

[9]See Tamminga & Fruehwald (2013) and Tamminga & MacKenzie (2014) for more on coronal stop deletion at different grammatical levels in American English.

[10]There are some important observations to be made considering what happens when p-conditioning interacts with the other conditioning types; see the end of this subsection.

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causes with similar surface effects, but rather the even more complex problem of doing this when the two causes also interact.

Finally, we have also already seen that surface variability may have more than one underlying source. From this idea, it is not a great conceptual leap to envision that individuals may differ in *which* of these underlying sources are present in their grammars. For example, consider the variable of [ð]-stopping, the use of a stop or flap in place of a voiced interdental fricative, which is typically a stigmatized working-class feature in the English-speaking communities where it is found. While the stop variant attracts this stigmatization, Labov (2001) points out that there exists a range of pronunciations between a pure fricative and an affricate that do not seem to carry the same social evaluation. Suppose that it turned out that everyone has a range of initial closure degree for interdental fricatives due to the temporal demands of gestural alignment, sometimes resulting in a completely non-continuant pronunciation; this is a kind of p-conditioning. Suppose in addition that some individuals have a separate *phonological* stop–fricative alternation that is represented in the grammar and thus operates in terms of binary features, not gradiently. In this scenario, we might very well expect different p-factors to interact differently with the two different sources of [ð] variation. That is, if a p-conditioning factor interacted with the phonology, its effects would be manifested in individuals who have the "phonologized" version of the alternation; other p-conditioning factors such as speech rate might be expected to interact primarily with the gradient part of the alternation.[11] In this hypothetical scenario, the two subgroups in the population would show what might look like different reflexes of the influence of speech rate. Taken at face value this would be counterevidence to the predicted universality of p-factors, but would be no counterexample when the underlying differences in the linguistic representation of the variable processes are taken into account.

In much of the discussion in this section our goal has been to identify potential ways in which the effects of p-conditioning could be studied in the speech of individuals. In almost all of our examples, the important questions quickly become involved with issues from a number of different domains, concerning primarily (i) the nature of the different cognitive systems that drive p-conditioning effects; (ii) the ways in which p-conditioning might interact with grammatical representations, i-conditioning, and s-conditioning; and (iii) the possibility that different individuals might have different loci of variation (in terms of i- versus p-conditioning) for even relatively well-studied variables. We see these complications as a challenge to be faced by a new line of empirical research—both in (re-)examination of corpora, and, in particular, in the experimental domain, where many of the various complicating factors we have identified can be systematically controlled and manipulated.

4.3 Grammar and use

The idea that i-conditioning and p-conditioning are architecturally distinct speaks directly to questions about the relationship between *grammar* and *language use* that are central to the study of language. In particular, a distinction between p-conditioning and i-conditioning is straightforwardly compatible with an architecture in which grammar is distinguished from

[11]On the differential patterning of speech rate with different types of variable phenomena, see Coetzee & Pater (2011).

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use, with p-conditioning being one instantiation of what happens when speakers use grammars in real time.[12]

It is important to explain exactly what is at issue in the grammar versus use discussion, since questions about this have many different dimensions, and are discussed from distinct theoretical positions with potentially inconsistent terminologies. By *grammar*, we mean a formal system of representations and computations that make one set of linguistic objects *grammatical* (those that are derived by the system, in a generative theory), and another set *ungrammatical* (generatively, those objects that are not derived). The nature of the representations and rules (or their equivalent) of the grammar have been a central concern of a large part of linguistic theory for the past sixty years or so. By *use*, we mean a system that employs grammars in real time to produce and comprehend utterances. In terms of this distinction, p-conditioning derives from use, whereas i-conditioning can (at least in principle) be attributed to variability in the grammar itself.

One fruitful way of understanding the relation between grammar and use is in terms of the distinctions made in Marr (1982), who describes complex neurocognitive capacities like language in terms of three distinct levels of analysis:

(6) Marr's levels of analysis

a. Computational Theory: What is the goal of the computation, why is it appropriate, and what is the logic of the strategy by which it can be carried out?

b. Representation and Algorithm: How can this computational theory be implemented? In particular, what is the representation for the input and output, and what is the algorithm for the transformation?

c. Hardware Implementation: How can the representation and algorithm be realized physically?

In these terms, the typical approach within theoretical linguistics is to construct theories at the Comptuational level: theories that specify what is grammatical and what is not, in ways that abstract away from real-time implementation, memory limitations, errors in performance, and so on. On the other hand, psycholinguistic theories, which are directed at how language is produced and comprehended in real time, are directed at the Representation and Algorithm level of analysis. (For discussion of (psycho)linguistics in these terms, see Lewis & Phillips (2015), and for connections with the neurobiological domain, see Poeppel & Embick, 2005 and Embick & Poeppel, 2015).

In Sections 4.1 and 4.2 we have advanced two hypotheses under the general idea that p-conditioning and i-conditioning are distinct: first, that conditioning is asymmetrical, such

[12]Our distinction between grammar and language use picks up on a recurrent theme in the literature and could connect to many prior such distinctions (for a perspective close to the one in this paper see Embick (2008)). For example, the distinctions between *competence* and *performance* (Chomsky, 1965) and between *I-Language* and *E-Language* (Chomsky, 1986) are directly relevant to our concerns. The first distinction corresponds in certain important ways to the grammar/use distinction as we envision it; the latter has important connections with our central claim that variation must be understood in relation to individuals' grammars (and other cognitive systems), not just at the community level. We leave a detailed examination of these connections for another occasion.

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that certain effects on alternations must be p-conditioning and not i-conditioning; and second, that p-conditioning is universal while i-conditioning is arbitrary. If these claims are correct, they would follow naturally from a theory in which grammar and use are distinct, but would require puzzling stipulations in a theory that eschews this distinction. The following two paragraphs elaborate briefly.

Asymmetries in conditioning (4.1)—In a theory in which grammar and use are distinct, it is easy to explain why certain (non-local) alternations (like the ones influenced by priming, for example) must necessarily be variable and p-conditioned: p-conditioning arises from the properties of the cognitive systems involved in the use of grammars. A theory that collapses grammar and use, on the other hand, would be hard-pressed to explain why alternations that are grammatically nonlocal should necessarily be variable (and show properties of the systems that produce p-conditioning).

Arbitrary i-conditioning versus universal p-conditioning (4.2)—In a theory that separates grammar and use, this difference follows naturally as well: p-conditioning derives from universally shared cognitive systems that are involved in the use of grammars, whereas i-conditioning is by its nature grammatical, and thus potentially different for different languages and speech communities. A division of this type would be difficult to capture in a theory that denies the clear distinction between the cognitive systems of grammar and use.

In summary, our claim is that important facts about the conditioning of alternations follow naturally in an architecture in which grammar and use are distinct. This is, of course, not to say that a framework with no such distinction cannot say something about the kinds of facts we have discussed above; rather, the question is whether a usage-based view is able to adequately explain why the factors that shape the use of linguistic alternations appear to be different in kind.

We are aware that distinguishing between grammar and use is controversial, particularly so in the more experimental and quantitative areas of language research. Our goal here has been to suggest that progress can be made in understanding the dynamics of variation in individuals by making such a distinction, because of the predictions that we have outlined in this section. We hope that at a minimum, connecting the quantitative details of variation with the larger issues of grammar versus use in this way lays the foundation for more sustained theoretical evaluation of these (and other) architectural matters.

5 Conclusion

The first sections of this paper outline the Dynamics of Variation in Individuals Question and propose a framework in which this question and others related to it can be explored. The framework we advance distinguishes three distinct types of conditioning factors that affect variable processes in real time: i-conditioning, s-conditioning, and p-conditioning. Much of our discussion in this paper has concentrated on p-conditioning and its relationship to i-conditioning.

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With respect to p-conditioning, Sections 3 and 4 develop two main themes. First, Section 3 connects the operation of domain-general cognitive factors to their effects on the production of variation in real time, as evidenced in sequences of variants. Section 3.1 outlines a number of factors that fall under the umbrella of p-conditioning, such as production planning and priming. Section 3.2 proposes that the impact of such factors is most naturally detected in structured variation within temporally-ordered sequences of variable tokens, and suggests dynamism and microcovariation as two avenues for quantitative inquiry into such sequences. Section 3.3 juxtaposes our suggestions with the standard practice in variationist sociolinguistics and argues that the two approaches must be taken together as parts of an integrated theory of linguistic variation.

Section 4 develops aspects of our approach that connect with broader architectural issues in the study of language. Section 4.1 explores the possibility that while i-conditioning and p-conditioning both may involve reference to linguistic objects in the context of a variable, p-conditioning allows long-distance and other types of interactions that are not possible for categorical rules of grammar. In Section 4.2, we examine another way in which i-conditioning and p-conditioning differ: while p-conditioning effects are hypothesized to be cognitively universal, and show the same effects (within a particular distribution) across all speakers and languages, i-conditioning effects are potentially parochial or language-specific. If correct, these points (and others related to them) follow naturally in a theory in which i-conditioning and p-conditioning are architecturally distinct. In turn, this distinction is, in our view, a manifestation of the cognitive separation between grammar and language use. The specific hypotheses that can be derived and tested from Sections 4.1 and 4.2 thus have important consequences for understanding basic architectural questions about grammar, language, and the cognitive systems that are involved in language use.

In many parts of the discussion above, we have described research surrounding the DVIQ as asking different questions from those posed in quantitative studies of variation at the community level, or as building on that work (since, for example, we need to know an expected “baseline” type of s-conditioning for an individual speaker before we can examine questions about p- and i-conditioning in real time). Clearly a large part of the research program outlined here is intended to complement work in quantitative sociolinguistics as typically practiced. However, there are also some indications that, in addition to asking a new set of questions, research on the dynamics of individuals can shed light on community-level findings that would otherwise be mysterious. For example, the effect of subject length on contraction rates, easily detected at the group level, might find explanation in the role of general production planning within the speech of individuals. We believe that looking seriously at language use in individuals will yield many more insights into why community-level variation is structured as it is.

Many of the discussions in this paper are preliminary, and in many cases we have needed to discuss possible findings abstractly, without specific illustrations. In addition, some crucial questions concerning how the different types of conditioning interact with each other have only been outlined in their most skeletal form, even though this type of question is of crucial importance when any particular case-study is examined in depth. Our hope is that by outlining a framework that identifies the potential types of conditioning to be investigated—

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and by showing how the specific questions addressed here intersect with questions of much more general interest—we have been able to provide a foundation for further work in this area.

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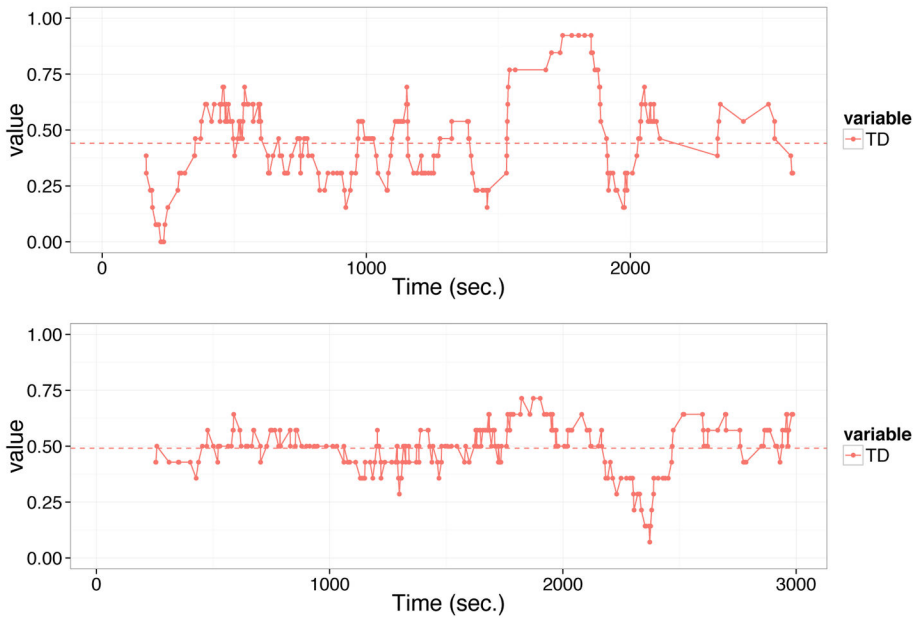

Figure 1.

High (top) and low (bottom) dynamism in two PNC speakers' moving averages for coronal stop deletion (window=N/20)

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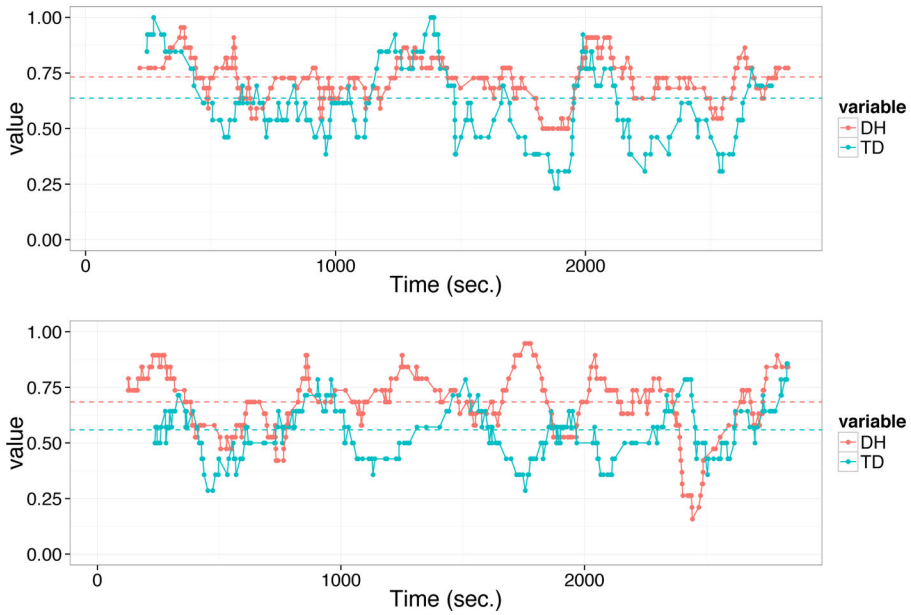

Figure 2.

Coincident (top) and divergent (bottom) microcovariation in coronal stop deletion and [ð]-stopping moving averages from two PNC speakers (window=N/20)