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Phonetic variation in bilingual speech: A lens for studying the production–comprehension link

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ABSTRACT

We exploit the unique phonetic properties of bilingual speech to ask how processes occurring during planning affect speech articulation, and whether listeners can use the phonetic modulations that occur in anticipation of a codeswitch to help restrict their lexical search to the appropriate language. An analysis of spontaneous bilingual codeswitching in the Bangor Miami Corpus (Deuchar, Davies, Herring, Parafita Couto, & Carter, 2014) reveals that in anticipation of switching languages, Spanish–English bilinguals produce slowed speech rate and cross-language phonological influence on consonant voice onset time. A study of speech comprehension using the visual world paradigm demonstrates that bilingual listeners can indeed exploit these low-level phonetic cues to anticipate that a codeswitch is coming and to suppress activation of the non-target language. We discuss the implications of these results for current theories of bilingual language regulation, and situate them in terms of recent proposals relating the coupling of the production and comprehension systems more generally.

Introduction

Despite the many potential pitfalls encountered during spontaneous conversation, communication between adult native speakers is generally relatively fluid and effortless. How do speakers and listeners coordinate the numerous subgoals involved in fluent language use, and to what extent does this coordination rely on sensitivity to the distributional properties of natural speech? This paper reports three studies that exploit the unique properties of bilingual language production and comprehension to investigate the resources available to interlocutors during spontaneous communication. Specifically, we examine the processing of phonetic variation related to cross-language activation during English–Spanish codeswitching. The overarching hypothesis is that pressures on the production system can give rise to regularities in the phonetic variation present in the speech stream, and that members of the speech community can ultimately come to exploit these regularities during comprehension. In essence, this proposal is a phonetic analogue of MacDonald's (2013) Production–Distribution–Comprehension account; but where MacDonald focuses on morphosyntactic aspects of linguistic form and processing – asking how processes related to memory retrieval affect word choice and syntactic formulation – we argue that the same logic can be applied to processes involved in the production and comprehension of phonetic variation. We note here that neither the production nor comprehension sides of this proposal are entirely novel. Previous studies of language production have explored processing-related sources of phonetic variation (for monolingual speakers, cf. Bell, Brenier, Gregory, Girand, & Jurafsky, 2009; Gahl, Yao, & Johnson, 2012; Goldrick &

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Blumstein, 2006; for bilingual speakers, cf. Amengual, 2012; Goldrick, Runnqvist, & Costa, 2014; Jacobs, Fricke, & Kroll, 2015), and studies of language comprehension have repeatedly demonstrated that listeners develop acute sensitivity to low-level phonetic regularities (for monolingual listeners, cf. Beddor, McGowan, Boland, Coetzee, & Brasher, 2013; Dahan, Magnuson, Tanenhaus, & Hogan, 2001; McMurray, Tanenhaus, & Aslin, 2002; for bilingual listeners, cf. Ju & Luce, 2004). The novel aspect of our proposal is its focus on the interplay between these processes, and on the mechanisms that support them. To better understand the processes and mechanisms involved, we take advantage of a particular type of language use that sheds light on the relationship between psycholinguistic processing and phonetic variation: codeswitching.

Why codeswitched speech?

Codeswitching offers a window into the relation between linguistic form and processing. Codeswitching is a specialized form of language use, subject to a unique set of linguistic (e.g., Myers-Scotton, 2002; Poplack, 1980; Torres Cacoullos & Travis, 2015) and psycholinguistic (e.g., Broersma & De Bot, 2006; Hartsuiker & Pickering, 2008; Kootstra, Van Hell, & Dijkstra, 2012) constraints, and engaging a dedicated mode of language control processes (e.g., Green & Abutalebi, 2013). Habitual codeswitchers are able to regulate the activation of psycholinguistic representations in a way that allows them to fluidly interleave their two languages without obvious disruptions in processing. The surface form of codeswitched speech thus ultimately reflects the end of a long chain of complex processing events, including production-internal processes (Levelt, 1989) as well as interactions between the production and comprehension systems (e.g., Kootstra, van Hell, & Dijkstra, 2010; Loebell & Bock, 2003). On the flip side, listeners' responses to codeswitched speech can provide an index of their expectations given previous experience processing a particular linguistic input (Valdes Kroff, Dussias, Gerfen, Perrotti, & Bajo, 2015). In sum, codeswitched speech presents a rich and relatively transparent opportunity for investigating the ways in which the members of a speech community come to produce and comprehend variation in linguistic form.

At this point, it is important to draw a distinction between the study of codeswitched speech and the study of language switching. In studies using the language switching paradigm (e.g., Costa & Santesteban, 2004; Meuter & Allport, 1999), participants are typically cued to switch between their two languages while naming digits or pictures, and the requirement to switch languages generally results in a "switch cost" to response times. It is therefore reasonable to hypothesize that the need to regulate two languages constitutes a source of pressure on the production planning system that could impact the surface form of codeswitched speech. However, experimentally manipulated language switching differs from codeswitching in a number of important ways. Language switching studies typically examine single word production, where the target language can vary at random and is determined by the experimenter (but see Gollan & Ferreira, 2009). During codeswitching, by contrast, grammatical planning mechanisms are fully engaged, the language of all lexical and morphosyntactic elements is fully under the control of the speaker, and in a normal conversational setting, production must additionally be coordinated with comprehension of the interlocutor's speech (Gullberg, Indefrey, & Muysken, 2012). A critical question, then, is whether the switch costs (and cross-language phonological influence; see below) that have previously been observed in experimental settings are particular to laboratory speech, or whether there is any evidence that language regulation has appreciable consequences during spontaneous conversation; it is in no way clear that production planning in these two settings is subject to the same set of demands.

If production patterns during spontaneous codeswitching come to reflect the language regulation processes of bilingual speakers, sensitivity to these regularities would undoubtedly prove beneficial for bilingual listeners. Bilingual comprehension, like production, is widely thought to be language non-selective: a multitude of evidence indicates that even highly proficient bilinguals continue to activate representations in the non-target language, despite the fact that such non-target activation may incur a processing cost (Thomas & Allport, 2000; Von Studnitz & Green, 2002). However, a small amount of work indicates that under some circumstances, bilinguals may take advantage of exogenous cues to language identity to minimize the influence of the non-target language during comprehension (e.g., Ju & Luce, 2004; Libben & Titone, 2009; Schwartz & Kroll, 2006), and interestingly, there may be reason to believe that such cues are relatively more accessible during auditory processing. We return to this point in further depth below. Importantly, very little work (in either the production or comprehension domains) has focused on habitual codeswitchers, arguably the group of language users most likely to develop sensitivity to any statistical regularities in the speech stream that could act as cues to language regulation. The few psycholinguistic studies of codeswitching have examined proficient bilinguals who don't normally engage in codeswitching (e.g., Kootstra et al., 2010), but it is as yet largely unknown whether accumulated experience with codeswitching in particular is associated with quantitative or qualitative changes in the mechanisms involved in language regulation. A goal of the current paper is to begin to address this question: can the phonetic form of spontaneous speech provide insight into the language regulation mechanisms of habitual codeswitchers, and if so, can members of a codeswitching community capitalize on such phonetic variation during auditory comprehension?

The remainder of the paper is organized as follows. First, we present an overview of the ways in which bilingual language regulation has been hypothesized to affect the production planning process. We then describe the similarities and differences between the hypothesized pressures on the bilingual production system, and the demands placed on the comprehension system. Subsequently we present three studies: two corpus studies ask whether the phonetic form of spontaneously produced codeswitched speech reflects the processing demands