On the parity of structural persistence in language production and comprehension

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ABSTRACT

Structural priming creates structural persistence. That is, differences in experience with syntax can change subsequent language performance, and the changes can be observed in both language production and comprehension. However, the effects in comprehension and production appear to differ. In comprehension, persistence is typically found when the verbs are the same in primes and targets; in production, persistence occurs without verb overlap. The contrast suggests a theoretically important hypothesis: parsing in comprehension is lexically driven while formulation in production is structurally driven. A major weakness in this hypothesis about comprehension-production differences is that its empirical motivation rests on the outcomes of experiments in which the priming manipulations differ, the primed sentence structures differ, and the measures of priming differ. To sharpen the comparison, we examined structural persistence with and without verb overlap in both reading comprehension and spoken production, using the same prime presentation procedure, the same syntactic structures, the same sentences, and the same participants. These methods yielded abstract structural persistence in comprehension as well as production. A measure of the strength of persistence revealed significant effects of priming and verb overlap without significant comprehension–production differences. This argues for uniformity in the structural mechanisms of language processing.

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1. Introduction

1.1. Using language

Fundamental to the explanation of how humans communicate is an understanding of the mental processes that support language comprehension and production. A crucial requirement of successful communication is that speakers and listeners can access similar information about words and how words combine to express an idea. Thus, English listeners understand English speakers because they make use of shared knowledge about English words and syntactic rules. The same listeners experience speech in unknown languages as meaningless streams of sound. The simple difference is that knowing the speaker's language allows the listener to develop an idea that is similar enough to the speaker's that communication occurs. How this happens remains a mystery. How can an idea become sound, and sound become a vestige of the same idea? In the current study, we tested a hypothesis about what the syntactic systems of language production and comprehension do to make this feat possible.

Given how little we know about the relationship between language comprehension and language production, the simplest workable alternatives are obvious: Speakers and listeners call on similar information in

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similar ways, or they call on similar information in different ways. The information must be similar or communication would founder, but how the information is used could be the same or different in the two modalities. A strong hypothesis is that speakers and listeners know similar things and use their knowledge in similar ways (Bresnan & Kaplan, 1984; Kempen, Olsthoorn, & Sprenger, 2012; Pickering & Garrod, 2013; Sag & Wasow, 2011). Yet it is undeniable that listeners can understand words and sentences that they do not and perhaps cannot produce (Clark & Malt, 1984), that comprehension and production begin and end with different information, and that the peripheral sensory and motor apparatus for sensation and action are necessarily distinct. Even the creation of computational models in which comprehension and production call on the same information in the same ways is far from straightforward (Fodor, Bever, & Garrett, 1974). This argues for differences between listening and speaking.

Speculation aside, the debate is an empirical one with proponents and compelling evidence on both sides. Support for separable processing systems across comprehension and production comes from several areas of study, including the emergence of comprehension before production in language acquistion (Benedict, 1979; Gertner, Fisher, & Eisengart, 2006; Tomasello, 2000), the neuropsychological impairments that yield double dissociations between modalities in aphasia (Caramazza, 1997; Goodglass & Kaplan, 1972; Hillis & Caramazza, 1995; Linebarger, Schwartz, & Saffran, 1983), and the sheer difficulty of performance, with production seeming much harder (for instance, in driving; Lee & Watter, 2014; Recarte & Nunes, 2003). Nevertheless, there are counterarguments resting on evidence that is more consistent with substantial similarity across production and comprehension. In language acquisition, fine motor control may account for timing differences (Bonvillian, Orlansky, & Novack, 1983; Petitto & Marentette, 1991). In neuropsychological impairments, deficits in general cognitive resources might obscure underlying uniformity (Caplan, 1996; Caplan & Waters, 1995; Caplan, Waters, DeDe, Michaud, & Reddy, 2007). Apparent differences in difficulty could stem from people's typical failure to create as much representational detail after listening as before speaking, even though such detail is achievable (Bock, Dell, Chang, & Onishi, 2007; Kempen et al., 2012).

Particularly compelling observations about the relationship between comprehension and production come from situations where the two modalities continuously interact, like self-monitoring and conversation. Self-monitoring of one's own speaking and listening could depend on tight coupling between comprehension and production (Garrett, 1980; Levelt, 1983, 1989; Townsend & Bever, 2001), just as seamless interaction between comprehension and production is a necessity for coherent conversation. In both of these instances, episodes of comprehension may have an immediate impact on upcoming production, and vice versa. Garrod and Pickering (2004) described the mutuality between comprehension and production as a progressive process of *alignment* between conversation partners. As conceived, alignment means that speakers and listeners develop the same linguistic representations

for many kinds of referring expressions at many levels (Brennan & Clark, 1996; Watson, Pickering, & Branigan, 2004), including syntactic structure (Branigan, Pickering, & Cleland, 2000).

The linkage between language comprehension and production is a focus of current research on structural priming and persistence. Structural priming (incidental experience with a syntactic structure) and structural persistence (incidental adaptation to the same structure) have consequences for both speakers and listeners. (Note our use of the term *priming* to refer to experience with a structure and *persistence* to refer to structural consequences of that experience.) Whether the consequences or the mechanisms of priming are the same is a matter of debate. In the next two sections we consider the implications for this debate of existing findings about structural persistence.

1.2. Structural persistence in language production

What is structural persistence? Descriptively, structural persistence is the product of a structure-specific influence of an experienced syntactic pattern on later episodes of comprehension and production. It can arise even when lexical, semantic, and thematic information differ between a priming exposure and subsequent encounters with, or uses of, the same structure. For example, speakers who say *The 747 was landing by the control tower* are later on more likely to say *The mailman is being chased by a dog* than they would otherwise be, using a passive structure in the ensuing sentence even when its voice, topic, and just about everything else changes (Bock, 1986, 1989; Bock & Loebell, 1990).

Persistence of structure in language production has been observed for several kinds of structures in different languages (Bock, 1986; Bock & Loebell, 1990; Cleland & Pickering, 2003; Corley & Scheepers, 2002; Hartsuiker & Kolk, 1998; Hartsuiker & Westenberg, 2000; Konopka & Bock, 2009; Pickering & Branigan, 1998; Scheepers, 2003), in young children (Huttenlocher, Vasilyeva, & Shimpi, 2004; Savage, Lieven, Theakston, & Tomasello, 2003; Shimpi, Gamez, Huttenlocher, & Vasilyeva, 2007), in spontaneous speech (Gries, 2005), and in bilinguals, across their languages (Hartsuiker, Pickering, & Veltkamp, 2004; Loebell & Bock, 2003; Shin & Christianson, 2009). Most important for present purposes is that persistence in production arises regardless of whether priming occurs in an episode of language production or language comprehension (Branigan et al., 2000; Lombardi & Potter, 1992; Potter & Lombardi, 1998), with the same strength and duration (Bock, Dell, Garnsey, Kramer, & Kubose, 2007). That is, persistence in language production is a cross-modality phenomenon.

The occurrence of structural persistence between prime and target structures, without other shared information, is one of its theoretically most provocative features. What seems to persist is an abstract syntactic process or representation. Yet when information overlap *is* present, when specific words recur in specific structures, there is an increase in the magnitude of persistence (Cleland & Pickering, 2003; Pickering & Branigan, 1998). The increase has been demonstrated chiefly (but not exclusively) with the repetition of verbs, which play a prominent part in