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Proceedings of the Annual Meeting of the Cognitive Science Society

Title

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Permalink

<https://escholarship.org/uc/item/2rn53226>

Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 33(33)

ISSN

1069-7977

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Publication Date

2011

Peer reviewed

Core phonology: Evidence from grammatical universals

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The human capacity for language is one of the most contentious topics in cognitive science. While some researchers attribute language to domain-general mechanisms, others postulate a specialized language system. When it comes to the phonological component, however, even proponents of domain-specificity concede that specialization is unlikely (Fitch *et al.*, 2005). Phonological competence, in this view, is the product of experience, auditory perception, and motor control. And indeed, phonological systems are intimately grounded in phonetics. But while the domain-general perspective can account for this fact, it offers no explanation for several key features of language. It fails to explain why all languages—signed and spoken—have a phonological system, why phonological systems emerge spontaneously, in the absence of a model (Sandler *et al.*, in press), and why the cultural invention of reading and writing invariably recapitulates phonological principles. Such observations, however, are readily explained by the view of phonology as a core knowledge system (Berent, in press).

Core knowledge systems are specialized, early knowledge frameworks and scaffolds for subsequent learning (Carey & Spelke, 1996). Crucially, core systems manifest a unique, universal design—it is the argument from design that presents the strongest test for specialization. Applying this test to phonology, one would expect that, if phonology is a specialized core-knowledge system, then all grammars should exhibit universal principles that are largely invariant across individuals. Like other species-specific communication systems (e.g., birdsong; Fehér *et al.*, 2009), universal phonological principles could be triggered by experience, but they are unattainable by learning (e.g. by statistical learning, induction, etc., Samuels, 2004).

Optimality Theory (Prince & Smolensky, 1993/2004) offers specific, amply testable hypotheses concerning those principles. In this account, all grammars include a common set of markedness constraints that express (dis)preferences for certain linguistic structures (e.g., structure A>B). These constraints form part of the grammars of all speakers, irrespective of whether the structures under consideration (e.g., A, B) are present in one's language or absent.

In this talk, I summarize the results of an experimental research program that tests of this hypothesis. I proceed in two steps. First, I demonstrate that individual speakers' preferences mirror the language typology. I next gauge the source of these preferences by pitting universal-grammatical explanations against various extra-grammatical alternatives.

My specific case study concerns the sonority-related restrictions on onset structure (e.g., *bl* in *block*). Across languages, onsets such as *bl* are preferred (e.g., they are

more frequent) relative to onsets like *bdif*, which, in turn, are preferred to *lbif*. Figure 1 illustrates this regularity in a representative sample of 90 diverse languages (data from Greenberg, 1978).

These systematic distributional regularities are attributed to sonority (*s*)—a scalar phonological property that correlates with intensity: liquids (e.g., *l*) are more sonorous ($s=3$) than nasals (*n,m*; $s=2$), which in turn, are more sonorous than stops (e.g., *b,p*; $s=1$). Accordingly, onsets such as *bl* manifest a large cline in sonority ($\Delta s=3$), *bn* has a smaller cline ($\Delta s=3$), *bd* manifests a sonority plateau, whereas *lb* exhibits a sonority fall ($\Delta s=-3$). The typological preference (e.g., *blif*>*bnif*>*bdif*>*lbif*) is thus captured by grammatical constraints that favor onsets of large sonority clines—the larger the cline, the less marked the onset (Clements, 1990). Of interest is whether those constraints are universally active in the grammars of individual speakers.

To address this question, I examine whether people favor onsets of large sonority clines over smaller clines even when such onsets are unattested in their language. Participants' preferences, in turn, are gauged from their capacity to accurately identify these onsets. Past research has shown that speakers systematically misidentify ill-formed onsets that are unattested in their language (e.g., *tla* → *tala*; Pitt, 1998). Grammatical ill-formedness presents one explanation for this phenomenon (Anttila, 1997). In this account, the markedness of ill-formed onsets prevents their faithful encoding by the grammar, and consequently, such onsets must be systematically recoded as better-formed structures (e.g., as *tela*). To the extent small sonority clines are ill-formed, then onsets with small sonority clines (e.g., *lb*) should be recoded, hence, more likely to be misidentified than better-formed onsets (e.g., *bd*).

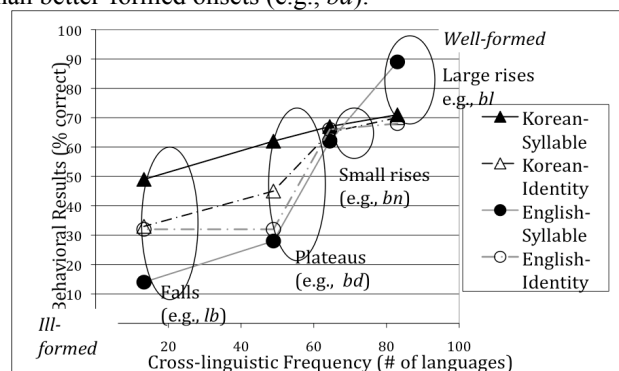


Figure 1: The link between sonority cline of onsets, their frequency across languages and their identification by English and Korean speakers in syllable count and AX identity tasks (Berent *et al.*, 2007; 2008).

Results from numerous experiments show that the identification of marked onsets is linked to their sonority profile (see Figure 1). For example, English speakers—both adults (Berent & Lennertz, 2007; Berent *et al.*, 2007; Berent, 2008; 2009; 2010a) and young children (Berent *et al.*, 2010b)—are more likely to misidentify the ill-formed *lbif* compared to the better-formed *bdif*: they are more likely to incorrectly identify *lbif* as disyllabic, and they erroneously judge it as identical to *lbif*. Crucially, this systematic misidentification of marked onsets compared to unmarked ones obtains despite no experience with either

Misidentification, of course, could also occur for numerous reasons unrelated to sonority. English speakers, for example, could conceivably misidentify *lbif* because it is dissimilar to attested English onsets, because the acoustic properties of *lbif* are ambiguous, or because its phonetic form is difficult to encode. But auxiliary analyses demonstrate that the perceptual illusions of English speakers are not due to artifacts of the auditory stimuli (Russian speakers identify the same stimuli accurately, e.g., Berent *et al.*, 2007) or an inability to encode their phonetic form. Indeed, English speakers identify the same aural stimuli adequately once they attend to their phonetic forms (e.g., Berent *et al.*, 2011), but when phonological encoding is required, misidentification are found even with printed materials, Berent *et al.*, 2009; Berent & Lennertz, 2010). The superior identification of unmarked onsets also does not result from their resemblance to attested English onsets (e.g., to *bl*). In fact, similar findings obtain in Korean—a language that arguably lacks onset clusters altogether (Berent *et al.*, 2008; see Figure 1).

By elimination, then, I conclude that the misidentification of marked onsets reflects broad grammatical constraints that re-emerge consistently, perhaps universally, despite substantial variation in linguistic experience. The unique, shared design of phonological grammars, on the one hand, and the intimate link between phonological competence and reading (a cultural invention) on the other, are consistent with the view of the phonological grammar as a specialized system of core knowledge.

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