Production Influences on Phonological Representation in an Emergentist Grammar

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Historically, there has been tension between accounts of child speech patterns that attribute them either to physical constraints on production or else to rule- or constraint-based formalisms. Such performance-based and competence-based accounts of child phonology have often been framed as mutually exclusive (Davis, MacNeilage, & Matthey, 2002; Hale & Reiss, 2008), but newer models in which abstract phonological representations emerge from more phonetically detailed representations (e.g., Pierrehumbert, 2002; Werker & Curtin, 2005), create the opportunity for an intermediate account. However, the line of experimental research detailing how motor pressures shape early lexical and phonological development has developed largely independently of the theoretical and experimental literature positing the emergence of abstraction from phonetically detailed underpinnings. While previous works have anticipated how these lines of research might intersect (e.g., Fikkert & Levelt, 2008; StoelGammon, 2011; Majorano et al., 2013), no account has to our knowledge explicitly laid out the predictions generated when they are brought together.

Literature 1. Effects of production difficulty on early phonological development. The sounds and syllable shapes that an infant produces during pre-linguistic babbling are overrepresented in the first 50 words that the child attempts to produce (e.g., Bernhardt & Stoel-Gammon, 1996; Stoel-Gammon, 2011), and these influences cannot be fully reduced to either universal markedness or frequency in maternal input (e.g., DePaolis et al., 2011). The leading view holds that a stable articulatory routine or “vocal motor scheme” can support the encoding of a speech sound or string in phonological memory (e.g. McCune & Vihman, 2001; Stoel-Gammon, 2011). Recent evidence from neuroimaging (Kuhl et al., 2014) and behavioral studies of infant speech processing (e.g., Majorano et al., 2013) point to a plausible neurobiological basis for this phenomenon. When children hear speech strings that they have little or no experience producing, some processing resources must be dedicated to the search for the motor command(s) that will most closely map to that auditory string. By contrast, when hearing speech strings that they have more frequently produced, children can efficiently retrieve the associated motor representation, freeing up more resources for learning a sound-meaning mapping or to strengthening its representation in memory.

Literature 2. Emergentist models of phonological development. There is abundant evidence that speaker and listeners are sensitive to episodic detail, such as speaker identity and affect, and yet also use abstract categories in processing (Pierrehumbert, 2002). As a consequence, recent models of phonological learning often include both a detailed episodic level of representation and one or more higher levels, with each layer “abstracted progressively further away from the parametric phonetic encodings” (Munson, Beckman, & Edwards, 2011: 299). The most basic abstraction, in which segments emerge from word-level representations, can occur when children notice that their stored word-level traces contain areas of acoustic and motoric overlap (e.g., Werker & Curtin, 2005; see evidence in Ferguson & Farwell, 1975; Vihman & Croft, 2007; Munson et al., 2011). Other recent grammatical work has proposed that the initial segmental acquisition phase is followed by a gradual emergence of features (Levelt and van Oostendorp, 2007) and positional constraints (e.g. Fikkert and Levelt, 2008), in line with a broader shift away from representational innateness and towards models in which features and constraints coalesce out of observed data (e.g., Lin & Mielke, 2008; Hayes and Wilson, 2008, Adriaans and Kager, 2010).

Synthesis. Adopting an emergentist model of phonology means that the production influences known to shape early lexical selection and production preferences can also become grammatically encoded, and so should surface in more classically phonological developmental patterns. A child who has access to a particular speech string’s motor routine can devote more resources to strengthening and expanding the representation of that string in memory, with the consequence that the early lexicon will be dominated by words that the child can approximate in production. As the grammar begins to extract segment-level representations from word-level traces, the frequently-occurring, robustly encoded sounds
that the child has produced should continue to be overrepresented relative to sounds that the child has rarely or never produced. Further, if features emerge as generalizations over natural classes of segments, it follows that the earliest-emerging features will also be biased in favor of the early production repertoire (Levelt & van Oostendorp, 2007). Finally, if we assume that constraints as well as features are emergent, and constraints are defined in terms of combinations of features, then the earliest-emerging constraints must necessarily make reference to the earliest-emerging features. In this way, the production biases that shape the earliest stages of lexical development can propagate up through higher levels of abstraction. Our overarching aim is to demonstrate that incorporating individual-specific production experience into the construction of grammatical representations does not entail abandoning abstract grammar or its role in child speech. Instead, it enhances our ability to account for data that have proven problematic for purely innatist formal models, while allowing us to study phonological development within the broader context of cognitive development and motor maturation.


