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What can frequency effects tell us about the building blocks and mechanisms of language learning?

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Over the past decades, numerous studies have documented the way input frequency affects children's language learning on all levels: from the learning of sounds, through words, multiword sequences and more abstract constructions. This paper provides a timely and thorough review of the pervasiveness of frequency effects in first language acquisition, showing how frequency impacts not only vocabulary acquisition, but also children's learning of inflectional morphology, and more abstract syntactic constructions. The review shows that learning is sensitive to multiple frequency measures: from that of specific exemplars (e.g., the frequency of the word *cake*), through morphological types (e.g., the frequency of *-ed* as a past tense marker), to more abstract form–function mappings (e.g., that object relative clauses tend to have inanimate heads). Drawing on findings from both experimental and corpus-based studies, the authors argue that higher-frequency forms tend to be acquired earlier, and that both correct productions and error patterns can be traced back to input frequencies. The review brings together empirical findings from several distinct domains and argues convincingly that any model of language acquisition has to be able to account for them. However, it does not address the underlying causes or consequences of frequency effects. Here, I focus on the implications frequency effects have for how we understand the process and product of language learning.

Frequency effects are not interesting in and of themselves. They are interesting because they reveal something about the learning mechanisms and units used in language learning. Research over the past twenty years has shown that infants (and adults) are very adept at extracting distributional regularities from their environment, and can use this information to learn about linguistic structure (see Romberg & Saffran, 2010, for a review). These statistical learning abilities can help infants discover word boundaries (e.g., Saffran, Aslin, & Newport, 1996), phonetic categories (Maye, Werker, & Gerken, 2002), and even grammatical categories (e.g., Gomez & Lakusta, 2004). There are many parallels between these early statistical learning abilities and the frequency effects reported in this paper. In both cases, children attend to distributional information on multiple levels (between sounds, words,

word classes) and use it to make generalizations. In fact, children's sensitivity to frequency in their linguistic input can be conceptualized as an extension of these early statistical learning abilities. The two bodies of literature – which are usually studied separately – also raise similar challenges.

The main challenge is a mechanistic one: WHY do frequency effects emerge? One possible answer lies in the role of prediction in language learning. Predictability plays an important role in language processing: speakers form expectations about upcoming topics, words, and constructions and use that to guide on-line processing (e.g., Hale, 2006; Levy, 2008; Jaeger, 2010). Despite the importance of prediction in language processing, its role in first language learning has been relatively less explored. In looking at how input patterns influence learning, researchers have highlighted the role of frequency but not of predictability (a pattern that holds in this paper). Recent years have seen growing interest in the role of prediction in learning, with the successful application of discriminative learning theory to language learning (Arnon & Ramscar, 2012; Ramscar, Yarlett, Dye, Denny, & Thorpe 2010; Ramscar, Dye, & McCauley, 2013). In such models, learning happens when there is prediction error: when there is a discrepancy between what is expected and what is encountered in the environment. A major component of learning involves forming predictions about how language unfolds over time. While both frequency and predictability influence child language use (as is the case for adults), predictability offers a more functional explanation for why distributional information plays a crucial role in language learning. Children are not just 'counting up' how many times forms appear. Instead, they are trying to make sense of the world around them by developing their ability to predict what will happen next. Viewing the child's task as one of prediction (e.g., Chater & Christiansen, 2010; Elman, 1990; Ramscar *et al*., 2010) opens up new ways of thinking about the relation between what children hear (i.e., their input) and what they say (i.e., their output).

Frequency effects provide insight not only into the mechanisms used in learning (e.g., statistical learning, prediction), but also into the building blocks used in learning. Finding that children are sensitive to the frequency of multiword strings challenges the traditional notion of words as the basic building blocks for language learning and use (e.g., Pinker, 1999). The authors review many findings showing that children's correct and incorrect uses are affected by multiword frequency. For instance, children are better at repeating higher-frequency phrases (Bannard & Matthews, 2008) and make more errors when the incorrect string appears often in another construction (e.g., more errors like *me do it* when children are exposed often to correct preverbal uses like *let me do it*; Kirjavainen, Theakston, & Lieven, 2009). Such findings suggest that children use

multiword units as building blocks for learning, as predicted by usage-based models (e.g., Abbot-Smith & Tomasello, 2006; Lieven & Tomasello, 2008). This sensitivity to multiword information is not limited to young learners. There is growing evidence that adults are also sensitive to the distributional properties of multiword sequences and draw on such information in production and comprehension (e.g., Arnon & Snider, 2010; Arnon & Cohen Priva, 2013; Reali & Christiansen, 2007; Tremblay, Derwing, Libben, & Westbury, 2011). Taken together, the developmental and psycholinguistic findings highlight the parallels in processing words and larger sequences; and point to the importance of multiword units in language learning and use.

The past decades have seen a significant shift in the study of language acquisition from models that prioritized innate mechanisms and abstract knowledge (e.g., Pinker, 1999) to ones that emphasize children's input and learning mechanisms (e.g., Tomasello, 2003; Lieven & Tomasello, 2008). Frequency effects have played an important role in providing evidence for key usage-based predictions, in particular (a) the role of children's input in learning, and (b) the gradual move from lexically specific knowledge to more abstract knowledge. Today, there is extensive evidence documenting frequency effects in many languages and in many linguistic domains. We can now proceed to use these effects as a way to ask fundamental questions about the mechanisms of language learning and the resulting linguistic representations.

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