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Input versus intake – a commentary on Ambridge, Kidd, Rowland, and Theakson's 'The ubiquity of frequency effects in first language acquisition'

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Ambridge, Kidd, Rowland, and Theakston (this issue) present a compelling argument for the ubiquity of frequency effects in first language acquisition. Their primary goal is to persuade the reader that "frequency effects are … a phenomenon that any successful account [of child language acquisition] must explain". They argue that the learning mechanism is frequency sensitive, that frequency effects exist at different levels, that there are several kinds of frequency effects, and that frequent forms will be acquired before less-frequent forms (all other things being equal). I agree with the authors on these points, and would like to augment their claims by focusing my comments in two areas. First, I address the ceteris paribus condition and how it obscures many factors that deserve attention in their own right. Second, I complement their arguments by exploring the more practical implications for success in language and literacy development.

Ceteris paribus

The "all other things being equal" condition put forth by Ambridge and colleagues downplays the fact that all other things are likely never equal and at times cannot be separated from the input itself. That is, the authors argue that: "Our prediction … is that, in a regression analysis, input frequency will make a significant unique contribution to the variance of the outcome measure (in this case age of acquisition), even when all of these other factors are included in the model." I think we need a lot more work to figure out whether this is actually the case. Many social–cognitive factors that we know play a role in language learning remain unacknowledged in the review. For example, input that occurs during episodes of joint attention can have larger effects than input outside of joint attention episodes (Tomasello & Farrar, 1986); input directed to the child has more of an effect than overheard speech (Schneidman & Goldin-Meadow, 2012; Weisleder & Fernald, 2013); there are certain situational contexts where words are learned better than others (Medina, Snedeker, Trueswell & Gleitman, 2011); input that is responsive to the child's vocalizations is particularly useful (Tamis-LeMonda, Kuchirko

& Song, 2014); preschool children learn words better from speakers they know to be knowledgeable rather than uncertain (Sabbagh & Baldwin, 2001); or may learn more when vocabulary is embedded in challenging talk about the non-present (Rowe, 2012). Language is clearly not learned in isolation, thus one cannot credibly muffle these pragmatic, social–cognitive and situational influences into "all other factors being equal". Indeed, investigations of both input quality and frequency measures either find both to be predictive (e.g., Cartmill, Armstrong, Gleitman, Goldin-Meadow, Medina & Trueswell, 2013) or find the quality measure controlling for quantity predicts outcomes best (e.g., Rowe, 2012). Thus, I embrace the authors' claim that frequency matters, yet emphasize that there is not a one-to-one correspondence between input and intake. The more we understand these other factors that clearly contribute to the effectiveness of the input, the more we will understand the learning mechanism and how to optimize language acquisition.

Practical implications

Not only do frequency effects constrain theories about the learning mechanism, they also lead to substantial and consequential individual differences in language development. We know that caregivers vary extensively in the quantity and quality of child-directed speech they use with young children. This variability, while striking across social classes (e.g., Hart & Risley, 1995), is also evident within fairly homogeneous samples (Huttenlocher, Haight, Bryk, Seltzer & Lyons, 1991; Pan, Rowe, Singer & Snow, 2005). Critically, variability in the quantity (tokens) or diversity (types) of vocabulary in the input is consistently moderately and significantly associated with children's vocabulary size or growth, even with SES controlled (see Hoff, 2006, for a review); and is also associated with children's lexical processing skills (Weisleder & Fernald, 2013). Importantly, input variation is not limited to vocabulary, as parents also vary widely in the frequency and distribution of syntactic constructions they use with children, and this variability has implications for children's grammatical development. For example, Huttenlocher, Vasilyeva, Cymerman, and Levine (2002) found wide variability in the proportion of parents' utterances that were multi-clausal or complex and that, controlling for SES, this variability related to their children's use of complex sentences at home and at school.

The larger implications of this documented variation in input frequency and the resulting widespread individual differences in child language development are long lasting. Yes, all typically developing children learn language; however, they do so at different rates and those who start behind tend to stay behind (Stanovich, 1986). For example, children's early

vocabulary growth rates are strongly predictive of their vocabulary size in kindergarten (Rowe, Raudenbush & Goldin-Meadow, 2012) and children's oral language skills in kindergarten are a strong indicator of their later literacy and school success (Snow, Burns & Griffin, 1998). Oral language skills in kindergarten explain most of the SES effects on fourth-grade reading skills (Durham, Farkas, Hammer, Tomblin & Catts, 2007; Quinn, Wagner, Petscher & Lopez, in press). Indeed, large-scale studies of American children show that the SES–achievement gap in reading is already evident when children enter school (Reardon, 2011).

In light of these findings from studies on individual differences, I return to the first thesis in the review by Ambridge *et al*., regarding "Levels and Kinds". The authors argue that we can gain a greater understanding of the learning mechanism if we consider both absolute frequency effects (tokens or types) as well as relative frequency effects (frequency relative to a competitor form). This is a very important point, yet it is too limited. If we think about input effects at a broader level, averaged across individuals, and look at more global accumulated language skills, additional levels and kinds become relevant. For example, is there a minimum frequency that is necessary or a point where more is not necessarily better? Is it necessarily the relative frequency of a specific construction compared to an alternative construction that matters, or could diverse uses of constructions be beneficial at a more global level (e.g., Huttenlocher, Waterfall, Vasilyeva, Vevea & Hedges, 2010)? Does the proportion of specific uses of input matter more, on average, than the raw frequency? If so, what does this mean for the learning mechanism? In many cases only having large datasets will answer these questions, but these are the kinds of questions we should be asking, especially if we are interested in figuring out how to maximize language outcomes in young children.

There has indeed been a recent surge in work aimed at increasing the quantity or quality of input in an effort to improve children's language development. If input frequency does have robust effects then manipulating the input should result in improved language learning. We are currently implementing gesture training with low-income parents to improve child vocabulary development based on our previous findings that gesture input predicts child gesture and vocabulary development (Rowe & Goldin-Meadow, 2009). Others are implementing similar interventions focused on maternal responsiveness (McGillion, Pine, Herbert & Matthews, 2014) and overall token and type frequency (Leffel & Suskind, 2013). These studies build directly off the limited existing experimental work on input effects (Landry, Smith & Swank, 2006), and are starting to show positive results (e.g., Leffel & Suskind, 2013). Thus, given the ubiquity of frequency effects, we should acknowledge their importance to learning theories and explore their practical implications more robustly.

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