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The when and how of input frequency effects*

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Ambridge and his colleagues (this issue) present a compelling argument and evidence for the need to consider frequency effects in a wide range of theories of language acquisition and development. As they note, many researchers have long believed that such effects are real and cannot be ignored. Furthermore, they appropriately acknowledge that many other factors may condition these frequency effects. In this commentary, along with several other factors, I will explore the effects of when and how frequency occurs. Such factors must be considered as part of the recognition of frequency effects in acquisition.

In a sense, issues surrounding the measurement of frequency in input and its relation to language development bear some resemblance to reaction time as a measure. Although there have been many studies and claims about reaction time changes over development or across individuals, global reaction time differences may well reflect something different across ages, tasks, or conditions. Furthermore, simply considering reaction time globally may obscure cognitive subprocesses. Global frequency effects are by no means uninteresting or unimportant as the authors maintain, but a more detailed examination of the when and how of frequency effects will lead to a clearer understanding of the role of frequency in language development.

One great challenge in determining frequency effects is when one looks for those effects in corpora: immediately, a session after frequency is measured, a week later, or months later. Furthermore, measuring frequency in corpora poses its own calculation problems. One answer to such challenges can be found in experimental studies of language learning.

Thirty-some odd years ago (Schwartz, 1978; Schwartz & Leonard, 1984; Schwartz & Terrell, 1983), I conducted a short-term longitudinal study of young children's very early word/category/concept learning. The children who participated were at an early stage of language development with five or fewer words in their production vocabularies (1;0 to 1;3 at the outset). Over the course of ten home visits, children were presented with sixteen sets (four objects or actions per set) of unfamiliar objects and actions (eight object sets and eight action sets), each of which was assigned a novel

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word, individualized for each child. A number of variables were examined, object versus action words, the phonological characteristics of the word in relation to the child's vocabulary and vocalizations, and the relations among the exemplars within each set (perceptually similar versus functionally similar). Within each set, two exemplars of each word referent were named frequently (FP, twice per session) and two were presented infrequently (IP, once per session) along with their names. This latter variable permitted an examination of the overall effect of frequency for the ten sessions, an examination of the number of presentations before first production, and, by comparing production through the middle session for FP exemplars and names to production of the IP items over the full experiment period, we could compare massed to distributed presentations. Overall, children named more FP (44%) than IP (29%) exemplars, but named IP presentations sooner (after seven presentations versus after twelve presentations). When the number of total presentations was held constant, the children named over nine IP exemplars, and barely over four FP exemplars. Thus, distributed presentations of novel words are more than twice as likely to lead to production than massed presentations.

There was a gap of over twenty years before frequency density in input was examined again (Childers & Tomasello, 2002). In this study, two-year-old children were also presented with experimental words for novel objects and actions (verbs), except there were multiple levels of massed and distributed presentations: massed (four or eight exposures in a single day), distributed (once a day for four consecutive or with three days in between) and CLUMPED (two exposures one day and two exposures three days later; or four on each of those days). The study also differed in that children were only taught six words (nouns or verbs) over a month and comprehension and production were tested at intervals after exposure. The relevant finding for the current discussion is that the poorest learning for production occurred in the massed presentations and children produced many more of the words that were presented over multiple days. The follow-up study demonstrated that a book-reading task before testing reduced performance substantially and that spacing presentations over more days (but not with too many days in between) yielded the most words produced. A similar paradigm was employed to examine children's learning of a complex grammatical structure (Ambridge, Theakston, Lieven & Tomasello, 2006). Again, the evidence supported a strong advantage for distributed presentations in producing a version of this structure with an untrained verb. This finding is particularly important because it demonstrates that the temporal distribution of input is not limited to lexical development. Such findings demonstrate the need for controlled and detailed examination of input frequency variables to fully understand the

important core argument for including frequency in theories of language development or acquisition.

Though these theoretical considerations for first language acquisition are of unquestionable importance, frequency is perhaps even more critical for children with language impairments (see a review by McGregor, Sheng & Ball, 2007). For these children, frequency is a key practice issue in the design and delivery of intervention. For example, children with SLI benefitted in their novel verb production from spaced and moderately frequent presentations, yet still exhibited rapid forgetting of these new words (Riches, Tomasello & Conti-Ramsden, 2005). In a study of novel irregular past tense verb learning by children with SLI, Proctor-Williams and Fey (2007) used different densities of recasts: none, conversation-like, and intervention-like. Children with SLI did not benefit from conversation-like density recasts compared to non-recast models but, importantly, intervention-like densities did not improve their performance.

The excellent review paper by Ambridge and his colleagues provides compelling evidence of frequency in our theories of first language acquisition. If we can agree that this is an important factor, regardless of theoretical orientation, it remains for us to explore the specific role of frequency effects. The studies discussed here represent a small number of manipulations of the temporal distribution of frequency and are only a beginning. The isolated findings supporting more distributed rather than massed presentations for children with language impairments are intriguing, but we have a great deal of work ahead to understand how frequency and density of presentation will best serve children with language impairments.

REFERENCES

Ambridge, B., Theakston, A. L., Lieven, E. V. M. & Tomasello, M. (2006). The distributed learning effect for children's acquisition of an abstract syntactic construction. *Cognitive Development* **21**, 174–93.

Childers, J. B. & Tomasello, M. (2002). Two-year-olds learn novel nouns, verbs, and conventional actions from massed or distributed exposures. *Developmental Psychology* **38**, 967–78.

Proctor-Williams, K. & Fey, M. E. (2007). Recast density and acquisition of novel irregular past tense verbs. *Journal of Speech, Language, and Hearing Research* **50**, 1029–47.

McGregor, K. K., Sheng, L. & Ball, T. (2007). Complexities of expressive word learning over time. *Language, Speech, and Hearing Services in Schools* **38**, 353–64.

Riches, N. G., Tomasello, M. & Conti-Ramsden, G. (2005). Verb learning in children with SLI: frequency and spacing effects. *Journal of Speech, Language, and Hearing Research* **48**, 1397–411.

Schwartz, R. G. (1978). *Words, objects and actions in early lexical acquisition.* Unpublished dissertation, Memphis State University.

Schwartz, R. G. & Leonard, L. B. (1984). Words, objects and actions in early lexical acquisition. *Journal of Speech and Hearing Research* **27**, 119–27.

Schwartz, R. G. & Terrell, B. T. (1983). The role of input frequency in early lexical acquisition. *Journal of Child Language* **9**, 57–64.