

Do children have a vocabulary spurt during their second year?

There is currently rather little agreement about the existence of, and explanation for, a vocabulary spurt in children during the second year.

Proposed explanations for a vocabulary spurt

- (1) Developmental factors endogenous to the child (e.g., : Dore, Franklin, Miller, & Ramer, 1976; Goldfield & Reznick, 1990; McShane, 1979; Reznick & Goldfield, 1992; (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Gopnik & Meltzoff, 1987; Lifter & Bloom, 1989; Mervis & Bertrand, 1994; Nazzi & Bertoncini, 2003; Poulin-Dubois, Graham, & Sippola, 1995; Ninio, 1995; Mills, Coffey-Corina, & Neville, 1993)
- (2) Leveraging techniques (Markman, Wasow, & Hanson, 2003; Gleitman & Gleitman, 1992; Plunkett, 1993; Walley, 1993)
- (3) Statistical properties of the data (McMurray, 2007; Mitchell & McMurray, 2008)

Spurt detection techniques

- (1) Calculate a ratio of vocabulary size to age (Schafer & Plunkett, 1998)
- (2) Specify number of words that must be learned in a given time period (Goldfield & Reznick, 1990; Gopnik & Meltzoff, 1987; Lifter & Bloom, 1989; Mervis & Bertrand, 1994; Ninio, 1995; Poulin-Dubois, et al., 1995; Reznick & Goldfield, 1992)
- (3) Visually inspect plots of vocabulary data over age (Dromi, 1987)
- (4) Fit particular functions to vocabulary data (Ganger & Brent, 2004)

Methods

Automatic Maxima Detection (AMD)

• Spline-based technique: Model sample of data pairs (*vocabulary size_t*, *observation time_t*) as a weighted linear combination of B-spline basis functions:

$$x(t) = \sum_k c_k \phi_k(t)$$

• Matlab-based implementation using Functional Data (FDA: Ramsay & Silverman, 2005)

• Download at: <http://insclab.org/lib/AMD/>

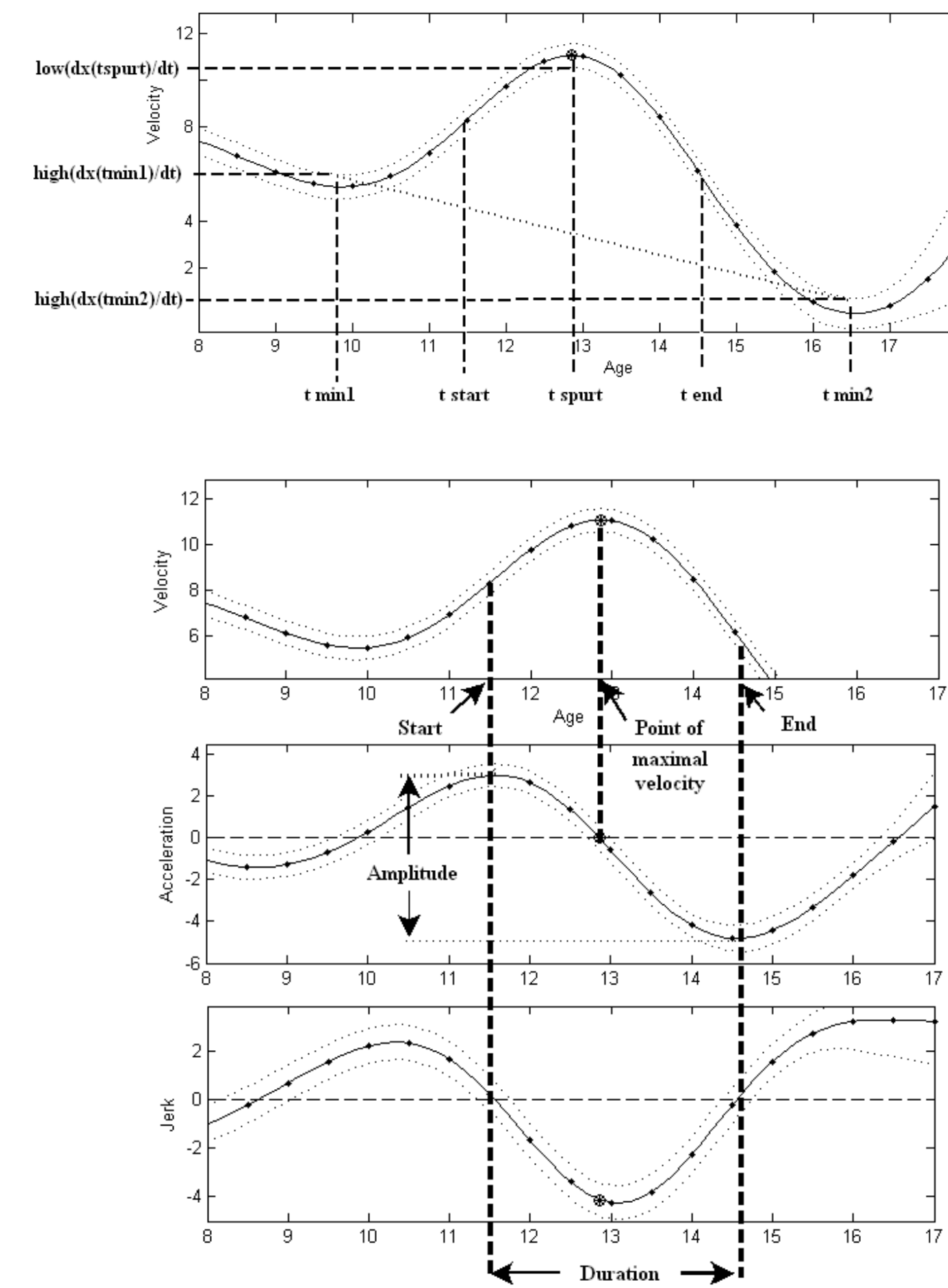
Applied to the analysis of data collected by Ganger (2004)

- 20 children
- Recorded daily over the second year of life

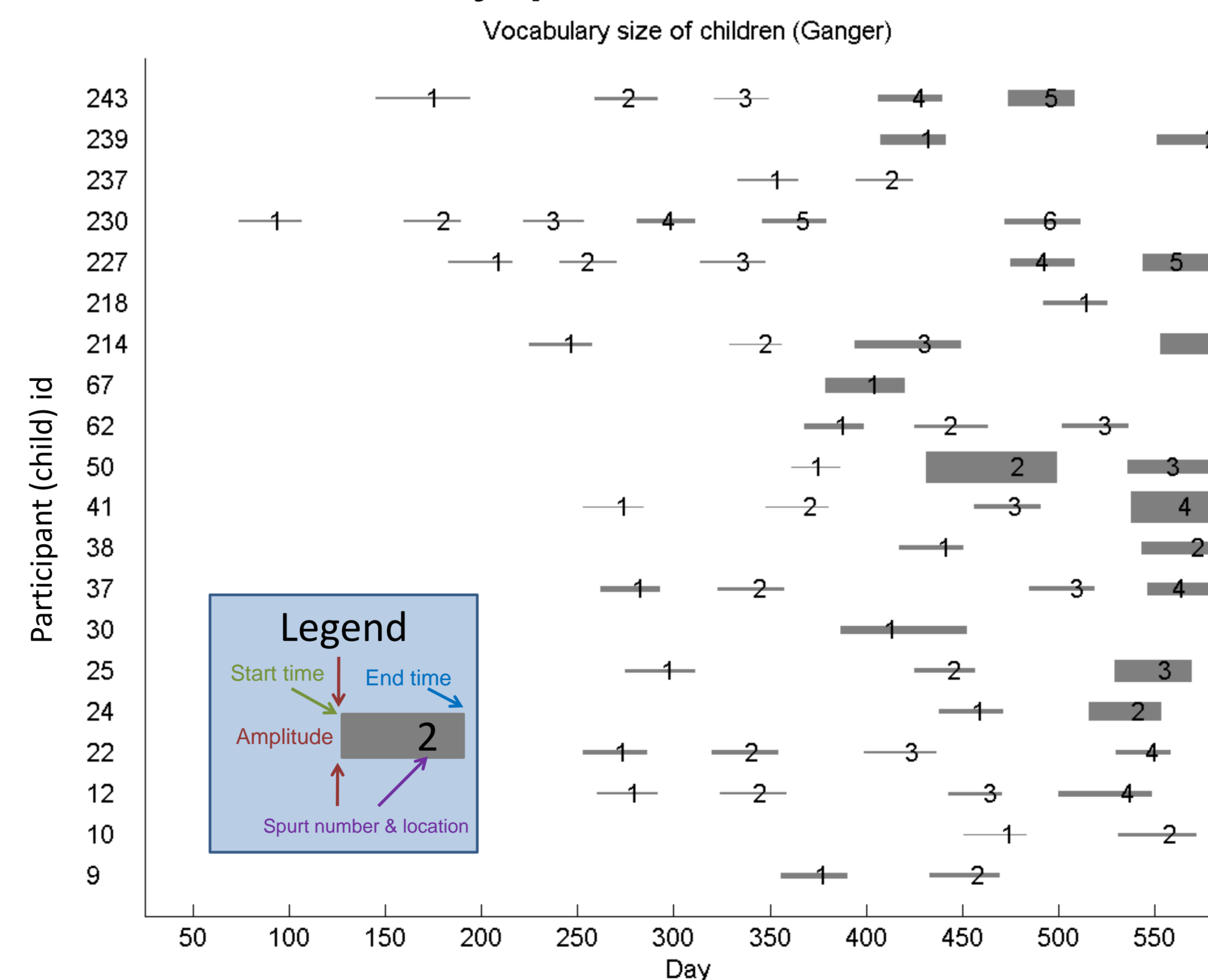
Contact: frederic.dandurand@gmail.com

Automatic Maxima Detection (AMD)

- (1) Automatically detects statistically reliable spurts
- (2) Quantifies spurts (maxima in velocity)



Summary plot for 20 children



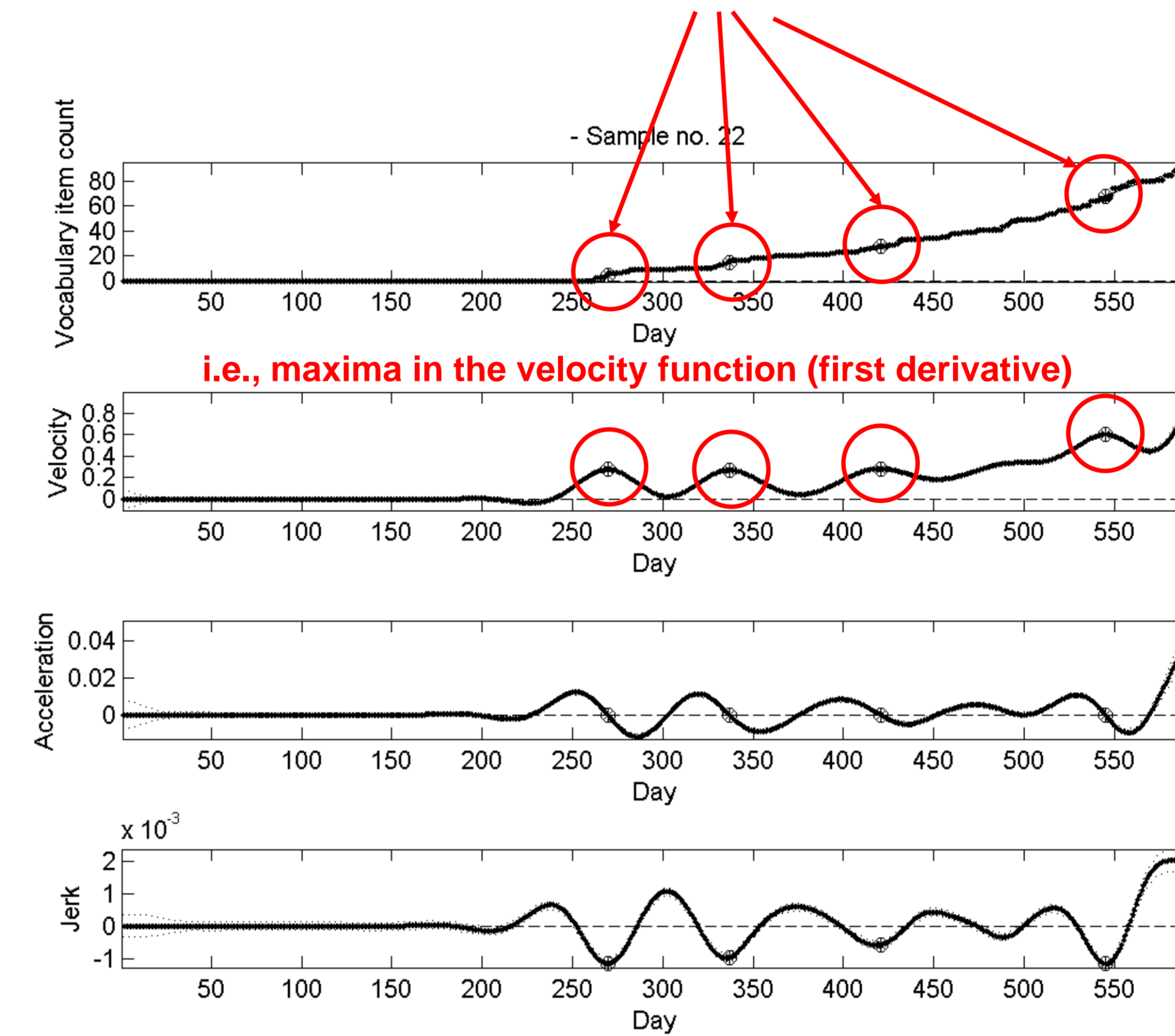
Spurts found: 3.0 (SD = 1.5)

Conclusion: Many statistically significant spurts detected; More work needed to assess their theoretical importance

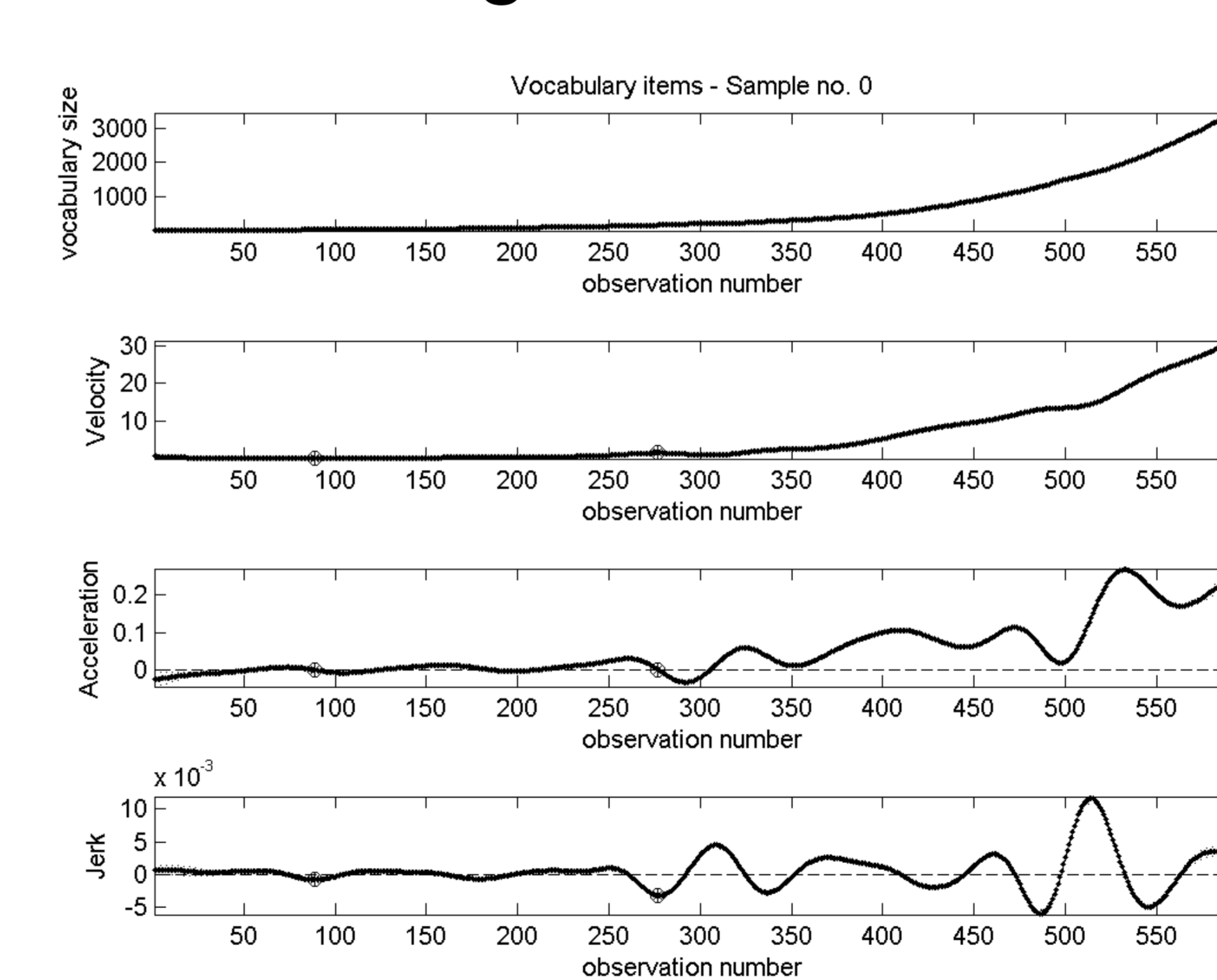
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Results

Example: child with 4 significant spurts



Average of all children



References

Bates, E., Benigni, L., Bretherton, I., Camaioni, L., & Volterra, V. (1979). The emergence of symbols: Cognition and communication in infancy. New York: Academic Press.

Bloom, P. (2000). How children learn the meanings of words. Cambridge, MA: MIT Press.

Brakman, S., Garretsen, H., & van Marrewijk, C. (2009). The new introduction to geographical economics (2nd ed.). Cambridge: Cambridge University Press.

Corrigan, R. (1978). Language development as related to stage 6 object permanence development. *Journal of Child Language*, 5, 173-189.

Dandurand, F., & Shultz, T. R. (2010). Automatic detection and quantification of growth spurts. *Behavior Research Methods*, 42(3), 809-823.

Dore, J., Franklin, M. B., Miller, R. T., & Ramer, A. L. H. (1976). Transitional phenomena in early language acquisition. *Journal of Child Language*, 3, 13-28.

Dromi, E. (1987). Early lexical development. Cambridge: Cambridge University Press.

Ganger, J. (2004). Data from Ganger & Brent 2004 (Publication). Retrieved 24 January 2011: <http://www.pitt.edu/~jganger/spurtdownloads.html>

Ganger, J., & Brent, M. (2004). Reexamining the vocabulary spurt. *Developmental Psychology*, 40, 621-632.

Goldfield, B., & Reznick, J. S. (1990). Early lexical acquisition: Rate, content, and vocabulary spurt. *Journal of Child Language*, 17, 171-183.

Gopnik, A., & Meltzoff, A. N. (1987). The development of categorization in the second year and its relation to other cognitive and linguistic developments. *Child Development*, 58, 1523-1531.

Lifter, K., & Bloom, L. (1989). Object knowledge and the emergence of language. *Infant Behavior & Development*, 12, 395-423.

Markman, E. M., Wasow, J. L., & Hanson, M. B. (2003). Use of the mutual exclusivity assumption by young word learners. *Cognitive Psychology*, 47, 241-275.

Mayor, J., & Plunkett, K. (2010). Vocabulary spurt: Are infants full of Zipf? In S. Ohlsson & R. Catrambone (Eds.), *Proceedings of the 32nd Annual Conference of the Cognitive Science Society* (pp. 836-841). Austin, TX: Cognitive Science Society.

McMurray, B. (2007). Defusing the childhood vocabulary explosion. *Science*, 317, 631.

McShane, J. (1979). The development of naming. *Linguistics*, 17, 879-905.

Mervis, C. B., & Bertrand, J. (1994). Acquisition of the novel name-nameless category (N3C) principle. *Child Development*, 65, 1646-1662.

Mills, D. L., Coffey-Corina, S. A., & Neville, H. J. (1993). Language acquisition and cerebral specialization in 20-month-old infants. *Journal of Cognitive Neuroscience*, 5, 317-334.

Mitchell, C. C., & McMurray, B. (2008). A stochastic model for the vocabulary explosion. In B. C. Love, K. McRae & V. M. Sloutsky (Eds.), *Proceedings of the 30th Annual Conference of the Cognitive Science Society* (pp. 1919-1924). Austin, TX: Cognitive Science Society.

Nazzi, T., & Bertoncini, J. (2003). Before and after the vocabulary spurt: two modes of word acquisition? *Developmental Science*, 6(2), 136-142.

Ninio, A. (1995). Expression of communicative intents in the single-word period and the vocabulary spurt. *Childrens Language*, 8, 103-124.

Plunkett, K. (1993). Lexical segmentation and vocabulary growth in early language acquisition. *Journal of Child Language*, 20, 1-19.

Poulin-Dubois, D., Graham, S., & Sippola, L. (1995). Early lexical development: The contribution of parental labeling and infants' categorization abilities. *Journal of Child Language*, 22, 325-343.

Ramsay, J., Hooker, G., & Graves, S. (2009). *Functional data analysis with R and MATLAB*. New York: Springer.

Ramsay, J., & Silverman, B. (2005). *Functional data analysis* (2nd ed.). New York: Springer.

Reznick, J. S., & Goldfield, B. A. (1992). Rapid change in lexical development in comprehension and production. *Developmental Psychology*, 28, 406-413.

Schafer, G., & Plunkett, K. (1998). Rapid word learning by fifteen-month-olds under tightly controlled conditions. *Child Development*, 69, 309-320.

Shultz, T. R. (2003). *Computational developmental psychology*. Cambridge, MA: MIT Press.

Walley, A. (1993). The role of vocabulary development in children's spoken word recognition and segmentation ability. *Developmental Review*, 13, 286-350.

Zipf, G. (1949). *Human behavior and the principle of least effort*. Cambridge, MA: Addison-Wesley.

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