Do features of child-directed speech correlate with children's success in building towers?

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The present contribution is part of a larger project that investigates the factors that guide the prosodic realization of infant- and child directed speech (IDS, CDS). In previous work, we showed that mothers differ in prosodic realization in non-serious compared to serious, goal-oriented situations (Braun & Zahner, 2020). Specifically, in that study we trained a classifier to distinguish between non-serious and serious game situations. Mean f0 was a strong predictor for serious situations (serious game situations had lower meanf0 than non-serious situations). Here, we present an exploratory analysis on whether the prosodic realization of CDS and success in a tower-building task are related.

To this end, we analyzed video recordings of thirteen two-year-old girls who had to build a tower consisting of 9 blocks of successively smaller blocks (3 blue, 3 yellow, 3 red), cf. Friedlmeier & Trommsdorff (1999). Mothers were allowed to help their daughters if they wished but were not instructed to do so. Beside motor coordination, which is necessary to successfully stack one block upon the other, the task primarily measures children's ability to compare the size of the blocks and sort them from the largest to the smallest. This skill is referred to as 'seriation' in the literature (e.g., Piaget, 1952) and has been argued to predict children's cognitive development as well as their later mathematical skills (Malabonga et al., 1995; Pasnak et al., 1996).

On average, the children worked on 2.5 towers (range 2-3). We operationalized success by the number of blocks that the child correctly added to the tower. Here we differentiated a strict coding (correct only if a block of the correct size was added) and a lenient coding (correct if any smaller block was added), resulting in two proportional correctness scores. We further coded for which of the blocks that the child added the mother gave explicit verbal help (e.g., "No, not the red one! Take the blue one") and derived the relative proportion. For prosodic analysis, we extracted all CDS utterances that occurred within a tower attempt (cf. Braun & Zahner, 2020). We averaged meanf0, sdf0, intended and realized syllables per second and number-of-words for each mother and tower attempt. Figure 1 shows the correlation between the two success variables (prop_corr_strict and prop_corr_lenient), proportion of explicit help (prop_verbal_helpblocks) and the aggregated prosodic variables (meanf0, sdf0, number of words, intended and realized syllables per second), cf. Wei & Simko (2017). We here focus on the strict correctness coding. The strongest correlation occurred between performance and explicit verbal help (r=0.6, 95% confidence interval [0.3;0.8]) and with sdf0 (r=0.5, 95%CI [0.05;0.7], see Fig.1(a). To investigate the immediate influence of prosodic variables, we calculated a logistic regression model (Baayen, 2008; Bates et al., 2015) with correctness of the block (strict coding) as dependent variable and the prosodic features of the utterance occurring up to 1 second before the event. There was a significant effect of sdf0 only (ß=0.006, SE=0.003, z=2.2, p=0.03); the more variability in f0, the more likely a correct event, see Fig. 1(b).

Overall, verbal instruction resulted in the strongest overall correlation with success of the tower building phases, as measured by the proportion of correct blocks. Furthermore, the prosodic realization immediately before the block event showed beneficial effects of higher variability in f0 (i.e. more intonational movement). It is conceivable, of course, that parents adapt their style to comment on their children's success afterwards. In future work we plan to differentiate between utterances whose content is relevant for the task.

(a) (b)

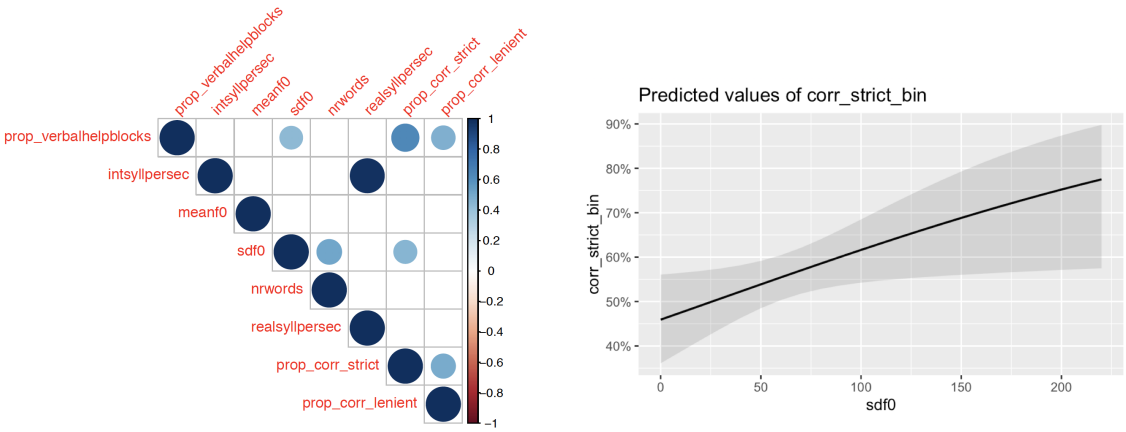

Figure 1. (a) Correlation plot between success variables (prop_corr_strict and prop_corr_lenient; last two columns), verbal help (prop_verbalhelpblocks) and prosodic and linguistic variables (intended and realized syllables/sec, number of words, meanf0, sdf0). Dot size shows the strength of the correlation; blue indicates positive, red negative correlations. Blank cells signal non-significant correlations at α=0.05. (b) Predicted effect of standard deviation of f0 on correctness. The gray band shows the 95% confidence interval.

References

Baayen, R. H. (2008). *Analyzing linguistic data. A practical introduction to statistics using R.* Cambridge: Cambridge University Press.

Douglas Bates, Martin Maechler, Ben Bolker, Steve Walker (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, 67(1), 1-48. doi:10.18637/jss.v067.i01.

Braun, B., Zahner, K. (2020). *Prosodic classification of serious and non-serious game situations using infant-directed-speech.* Paper presented at the Phonetik und Phonologie im deutschsprachigen Raum, Trier, Germany.

Friedlmeier, W., Trommsdorff, G. (1999). Emotion regulation in early childhood: A cross-cultural comparison between German and Japanese toddlers. *Journal of Cross-Cultural Psychology, 30*(6), 684-711.

Piaget, J. (1952). *The Child's Conception of Number*. Routledge.

Malabonga, V., Pasnak, R., Hendricks, C., Southard, M., & Lacey, S. (1995). Cognitive gains for Kindergartners instructed in seriation and classification. *Child Study Journal*, *25*(2), 79–96.

Pasnak, R., Madden, S. E., Malabonga, V. A., Holt, R., & Martin, J. W. (1996). Persistence of gains from instruction in classification, seriation, and conservation. *Journal of Educational Research*, *90*(2), 87–92. https://doi.org/10.1080/00220671.1996.9944449

Wei, T, Viliam Simko, V. (2017). R package "corrplot": Visualization of a Correlation Matrix. (Version 0.84). Available from https://github.com/taiyun/corrplot