Linguistic type-frequency in preschool boys and girls with and without hearing loss

Mark VanDam,[1,2] Jenna Anderst,[3] Daniel Olds,[1] Allison Saur,[1] & Paul De Palma[3]

[1]Speech & Hearing Sciences, Elson S. Floyd College of Medicine, Washington State University
[2]Hearing Oral Program of Excellence, Spokane HOPE School (https://spokaneHope.org)
[3]Communication Sciences & Disorders, Eastern Washington University
[4]Computer Science, Engineering & Applied Science, Gonzaga University
mark.vandam@wsu.edu | https://labs.wsu.edu/vanDam/

175th Meeting of the Acoustical Society of America
Minneapolis, MN | 08 May 2018

2pSC10

Background

Linguistic type-frequency A measurement of lexical diversity used to determine the total number of different words (Smith 1926; Davis 1937; Hess, Sefton, & Landry 1986; Bybee & Hopper 2001).

Type-frequency in development. Type frequency can provide insight into development (Turnbull & Justice 2017) and has been considered from perspectives including OT (Levelt, Schiller, & Levelt 2000), statistical frequency (Saffran, Aslin, & Newport 1996), exemplar based models (Jusczyk 1997), socio-usage models (Bybee 1995), among others.

Type-frequency in boys versus girls. Girls typically outperform boys in word acquisition during beginning years of language development (Hartshorne & Ullman 2006). Data conflicts whether this difference persists in school-aged children (Kaushanskaya, Gross, & Buac 2014).

Type-frequency with hearing loss. Consonant type (and token) frequencies favor TD over HL children (Stoel-Gammon & Otomo 1986). Lexical frequency favors TD over children with SLI (Owen & Leonard 2002). Some work on children with HL (Walter 1978) and with children with cochlear implants (Szagun 2000; Nott et al 2009).

Automatic methods to look at speech and language development. Resources such as LENA, CHILDES, Databrary, and HomeBank are used to collect and analyze large-scale audio recordings, improving ecological validity and certain types of data analysis, but prone to different types of errors and issues (VanDam, et al 2016).

Main research questions

1. **Does linguistic type-frequency differ in children with and without hearing loss?**
2. **Does linguistic type-frequency differ in boys and girls?**
3. **Does linguistic type-frequency interact with hearing status and sex of the child?**

Method

Participants

Participants include 53 families. 37 families (11 boys, and 26 girls) with toddlers who have a hearing loss **(HL)** with no comorbid diagnoses. 16 families (7 boys and 9 girls) with toddlers who were typically developing **(TD)**. The mean age was 29.8 months (SD=2.8 months) and age did not vary by sex or hearing status (p>.1). Children with HL had a mean BEPTA of 47.6 dB (SD=12.1 dB).

Materials

The LENA (Language ENvironment Analysis; LENA, Boulder, CO) was used to record daylong audio files. LENA processing algorithms were used to process data. Each daylong recording was blocked into 5-minute segments. The top three non-adjacent blocks with the greatest conversational turn values (as determined by the LENA estimates) were extracted. A total of 13.25 hours (159 5-minute blocks) of transcribed audio was analyzed. All blocks were transcribed by a panel of trained experts using CLAN (Computerized Language Analysis).

All (raw) audio files, complete transcriptions, and metadata concerning participants are publicly available via the HomeBank database in the *VanDam Public* corpus (VanDam 2018).

Procedure and data analysis

Data were collected from the CLAN transcriptions in the HomeBank database, and linguistic type-frequency raw and summary measures were generated using the default settings in CLAN. Raw values of the estimates of type frequency by recording were compiled. Welch's unequal variances *t*-tests were used to test for differences between groups, and estimates of the mean and 95% confidence intervals were computed and plotted in the figures.

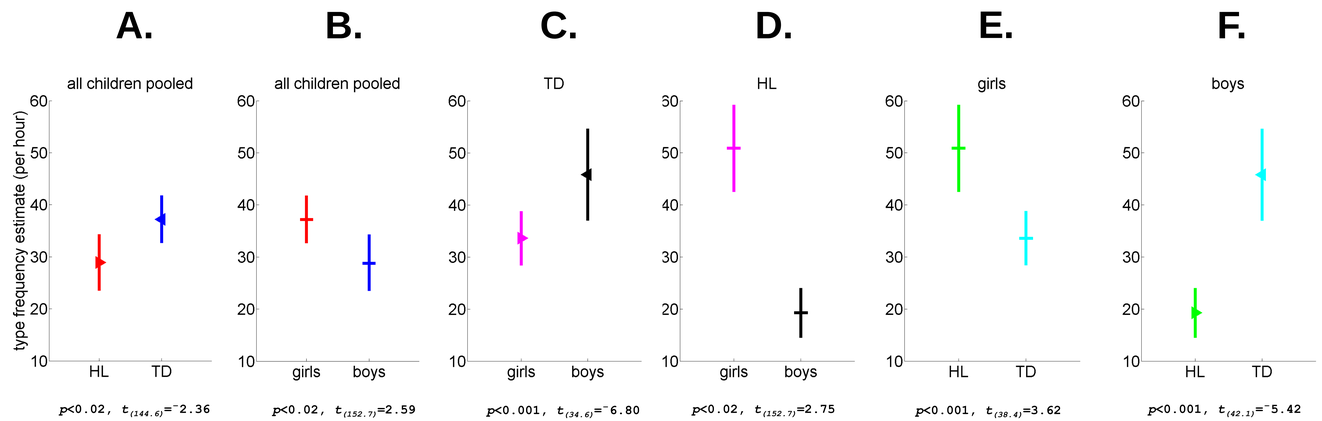

Figure 1. Type-frequency by hearing status and sex. Note: d.f. values in figures are computed using Satterthwaithe approximations, assuming unequal variances.

Results

1. **TD children show greater type-frequency than HL children (*Fig.* 1A).** ☺
2. **Girls show a greater type-frequency than boys (*Fig.* 1B).** ☺
3. **TD boys show greater type-frequency than TD girls (*Fig.* 1C).** 😐
4. **HL girls show greater type-frequency than HL boys (*Fig.* 1D).** ☺
5. **HL girls show greater type-frequency than TD girls (*Fig.* 1E).** 😐
6. **TD boys show greater type-frequency than HL boys (*Fig.* 1F).** ☺

Conclusions

1. Type-frequency differs between TD children and HL children and between girls and boys in the direction expected (Results 1 & 2).
2. Type-frequency differs between sex, but an interaction suggests HL children favor girls while TD children favor boys (Results 3 & 4). The TD boys advantage is unexpected.
3. Type-frequency differs between HL and TD children, but an interaction suggests boys favor TD children while girls favor HL children (Results 5 & 6). The HL girls' advantage is unexpected.

Future directions

1. Replication of this study with a larger sample, including different ages and hearing statuses.
2. Analysis of type-token ratios between typically developing children and children with hearing loss.

Acknowledgements

For raw data and to download the acoustic WAV files, go to `http://homebank.talkbank.org/`.
Work supported by The Washington Research Foundation and NSF-SBE RIDIR-1539133

References

Bybee, J. (1995). Regular morphology and the lexicon. *Language and Cognitive Processes*, 10, 425–455.
Bybee, J. L., & Hopper, P. J. (Eds.). (2001). *Frequency and the emergence of linguistic structure* (Vol. 45). John Benjamins Publishing.
Davis, E. A. (1937). *The development of linguistic skills in twins, singletons with siblings, and only children from age five to ten years*. Minneapolis, MN: University of Minnesota Press.
Hartshorne, J. K., & Ullman, M. T. (2006). Why girls say 'holded' more than boys. *Developmental science*, *9*(1), 21-32.
Hess, C. W., Sefton, K. M., & Landry, R. G. (1986). Sample Size and Type-Token Ratios for Oral Language of Preschool Children. *Journal of Speech and Hearing Research*, *29*.
Jusczyk, P. W. (1997). *The discovery of spoken language*. Cambridge, MA: MIT Press.
Kaushanskaya, M., Gross, M., & Buac, M. (2013). Gender Differences in Child Word Learning. Learning and Individual Differences, 27, 82–89. doi.org/10.1016/j.lindif.2013.07.002
Levelt, C. C., Schiller, N. O., & Levelt, W. J. (2000). The acquisition of syllable types. *Language acquisition*, *8*(3), 237-264.
Nott, P., Cowan, R., Brown, P. M., & Wigglesworth, G. (2009). Early language development in children with profound hearing loss fitted with a device at a young age: part II—content of the first lexicon. *Ear and hearing*, *30*(5), 541-551.
Owen, A. J., & Leonard, L. B. (2002). Lexical diversity in the spontaneous speech of children with specific language impairment: Application of D. *Journal of Speech, Language, and Hearing Research*, *45*(5), 927-937.
Turnbull, K. L. P., & Justice, L. M. (2017). Language Development from Theory to Practice. Upper Saddle River, NJ: Pearson.
Saffran, J. R., Aslin, R. N., & Newport, E. L. (1996). Statistical learning by8-month-old infants. *Science*, *274*, 1926–1928.
Smith, M. E. (1926). An investigation of the development of the sentence and the extent of vocabulary in young children. *University of Iowa Studies in Child Welfare*, Vol. III, No. 5, University of Iowa, Iowa City, IA.
Stoel-Gammon, C., & Otomo, K. (1986). Babbling development of hearing-impaired and normally hearing subjects. *Journal of Speech and Hearing Disorders*, *51*(1), 33-41.
Szagun, G. (2000). The acquisition of grammatical and lexical structures in children with cochlear implants: A developmental psycholinguistic approach. *Audiology and Neurotology*, *5*(1), 39-47.
VanDam, M. 2018. VanDam Public Corpus. Available at **`https://talkbank.homebank.org`**. doi:10.21415/T5388S
VanDam, M., Warlaumont, A. S., Bergelson, E., Cristia, A., Soderstrom, M., De Palma, P., & MacWhinney, B. (2016). HomeBank: An online repository of daylong child-centered audio recordings. *Seminars in Speech and Language*, 37(2), 128-142. doi:10.1055/s-0036-1580745
Walter, G. G. (1978). Lexical abilities of hearing and hearing-impaired children. *American Annals of the Deaf*, 976-982.