The Role of Social Network Size and Diversity in Vowel Identification in Noise

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Individuals differ in the variability of speech input they receive in everyday life. Research shows that this variability affects language acquisition and linguistic skills and has recently been operationalized using properties of individuals' social networks (i.e., the people they regularly interact with) such as their size and diversity (Hanulíková & Levy, 2025; Kutlu et al., 2024; Lev-Ari, 2016, 2018; Levy et al., 2019). Network *size* refers to the number of people an individual interacts with, whereas *diversity* refers to the degree of linguistic heterogeneity among them. Previous studies have mainly focused on network size as a proxy for input variability. Although this measure reflects input variability to some extent (Lev-Ari, 2016, 2018), it provides a rather rough estimate, as it does not account for the linguistic characteristics of network members' speech. The present study addresses this limitation by investigating whether linguistic diversity within social networks provides additional information about speech perception beyond network size.

The few studies including measurements of linguistic diversity assess characteristics known to contribute to systematic pronunciation variation, including regional and foreign accents as well as exposure to different phonological systems through other languages (Cowan & Olmstead, 2023; Hanulíková & Levy, 2025; Kutlu et al., 2024; Levy et al., 2019). Beneficial effects of input variability by exposure to multiple speakers or linguistic diversity have been found for phonological processing (Bradlow & Bent, 2008; Sumner, 2011) and speech comprehension (Hanulíková, 2021; Levy et al., 2019) and are often explained by the notion that variable input leads to the formation of robust categories (Raviv et al., 2022). Lev-Ari (2018) found that participants with larger social networks performed better in a vowel perception task. Expanding this research, we investigate whether German vowel identification in noise is predicted by social network size and, beyond that, by the linguistic diversity within these networks. We expected larger and more linguistically diverse networks to be associated with better vowel identification performance, reflecting additional benefits of exposure to linguistically variable speech input.

Participants (n=61) completed a questionnaire on their social networks, a vowel-identification-in-noise task, and two control tasks assessing attention skills (Flanker task) and receptive vocabulary (LexTALE). The main task included 126 monosyllabic nonwords, embedded in speech-shapes noise, across which 14 vowels of Standard German were evenly distributed. Participants responded with the perceived vowel. Network size was operationalized as the number of individual network members and diversity as the number of network members who spoke with a regional or foreign accent or in another language. Additionally, three separate diversity scores for regional accents, foreign accents and other languages were calculated, reflecting the percentage of the total weekly speech input associated with each variety, as effects of one type of input variability do not necessarily generalize to others (Levy et al., 2019).

Average identification accuracy was 59.46% (SD=11.67) and network size ranged from 2 to 28 members (M=9.58). Results model showed that participants with larger networks showed higher identification accuracy, suggesting that real-life exposure to many speakers may benefit speech perception and supporting the idea that this exposure may contribute to more robust phonological representations. Higher attention skills were also associated with better performance, indicating that attention skills may contribute to a challenging listening task or that participants with better attention skills may have been better able to maintain focus during the task. The lack of an effect of diversity could suggest that the measures used did not sufficiently capture the aspects of variability that are relevant for vowel identification or that the variability reflected by these measures may support other linguistic skills but not the specific skill testes in this study.

References

Bradlow, A. R., & Bent, T. (2008). Perceptual adaptation to non-native speech. *Cognition*, *106*(2), 707–729. https://doi.org/10.1016/j.cognition.2007.04.005

Cowan, T. M., & Olmstead, A. J. (2023). Exploring the Implications of Input Variability for Unfamiliar Accented Speech Perception: A Focused Review and New Hypotheses. *Languages*, *8*(1), 67. https://doi.org/10.3390/languages8010067

Hanulíková, A. (2021). Do faces speak volumes? Social expectations in speech comprehension and evaluation across three age groups. *PLOS ONE*, *16*(10), e0259230. https://doi.org/10.1371/journal.pone.0259230

Hanulíková, A., & Levy, H. (2025). Quantifying Experience with Accented Speech to Study Monolingual and Bilingual School-Aged Children's Speech Processing. *Languages*, *10*(4), Article 4. https://doi.org/10.3390/languages10040080

Kutlu, E., Baxelbaum, K., Sorensen, E., Oleson, J., & McMurray, B. (2024). Linguistic diversity shapes flexible speech perception in school age children. *Scientific Reports*, *14*(1), 28825. https://doi.org/10.1038/s41598-024-80430-1

Lev-Ari, S. (2016). How the Size of Our Social Network Influences Our Semantic Skills. *Cognitive Science*, *40*(8), 2050–2064. https://doi.org/10.1111/cogs.12317

Lev-Ari, S. (2018). The influence of social network size on speech perception. *Quarterly Journal of Experimental Psychology*, *71*(10), 2249–2260. https://doi.org/10.1177/1747021817739865

Levy, H., Konieczny, L., & Hanulíková, A. (2019). Processing of unfamiliar accents in monolingual and bilingual children: Effects of type and amount of accent experience. *Journal of Child Language*, *46*(2), 368–392. https://doi.org/10.1017/S030500091800051X

McQueen, J. M. (2005). Speech perception. In K. Lamberts & R. Goldstone (Eds.), *The handbook of cognition* (pp. 255–275). SAGE. https://www.torrossa.com/gs/resourceProxy?an=4912059&publisher=FZ7200#page=276

Raviv, L., Lupyan, G., & Green, S. C. (2022). How variability shapes learning and generalization. *Trends in Cognitive Sciences*, *26*(6), 462–483. https://doi.org/10.1016/j.tics.2022.03.007

Sumner, M. (2011). The role of variation in the perception of accented speech. *Cognition*, *119*(1), 131–136. https://doi.org/10.1016/j.cognition.2010.10.018