Voice paper

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Contents

Supplemental Methods

Statistical analysis

Individual and recording signal

We used the dis-similarity matrices from DTW, SPCC, MFCCCC or SPECAN to get a pairwise acoustic distance between all calls. We only included call pairs from the same year. We used a model similar to the Bayesian social relations model used in psychology. In our case the acoustic distance between any two calls was the response variable and was standardised before analysis. We included a global intercept and off-sets for: same vs different individual, same vs different recording, pair of individuals from which the calls came, pair of recordings from which the calls came and each call. The full model structure was as follows:

$$\text{accoustic distance} \sim \text{normal}(\mu, \ \sigma)$$
$$\mu_n = \bar{\alpha} + \alpha_{\text{same ind}[n]} + \alpha_{\text{same rec}[n]} +$$
$$\alpha_{\text{ind pair}[n]} + \alpha_{\text{rec pair}[n]} + \alpha_{\text{call i}[n]} + \alpha_{\text{call i}[n]}$$
$$\bar{\alpha} \sim \text{normal}(0, \ 0.25)$$
$$\alpha_{\text{same ind}} \sim \text{normal}(0, \ \sigma_{\text{same ind}})$$
$$\alpha_{\text{same rec}} \sim \text{normal}(0, \ \sigma_{\text{same rec}})$$
$$\alpha_{\text{ind pair}} \sim \text{normal}(0, \ \sigma_{\text{ind pair}})$$
$$\alpha_{\text{rec pair}} \sim \text{normal}(0, \ \sigma_{\text{rec pair}})$$
$$\alpha_{\text{call}} \sim \text{normal}(0, \ \sigma_{\text{call}})$$
$$\sigma_{\text{same ind}}, \ \sigma_{\text{same rec}}, \ \sigma_{\text{ind pair}}, \ \sigma_{\text{rec pair}} \sim \text{exponential}(3)$$
$$\sigma, \ \sigma_{\text{call}} \sim \text{exponential}(5)$$

We fitted an un-centred version of the model using *cmdstanr* (Gabry and Češnovar 2021) using the No U-turn Sampler in Stan (Gelman, Lee, and Guo 2015) in R (R Core Team 2021).

Supplemental Results

References

Gabry, Jonah, and Rok Češnovar. 2021. *Cmdstanr: R Interface to 'CmdStan'.*

Gelman, Andrew, Daniel Lee, and Jiqiang Guo. 2015. "Stan: A Probabilistic Programming Language for Bayesian Inference and Optimization." *Journal of Educational and Behavioral Statistics* 40 (5): 530–43.

R Core Team. 2021. *R: A Language and Environment for Statistical Computing.* Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.