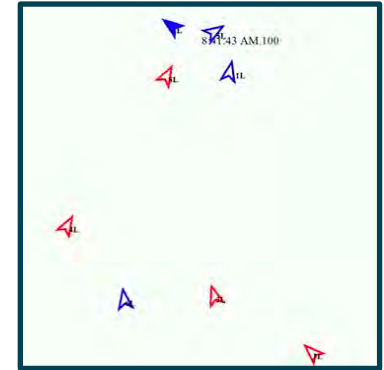
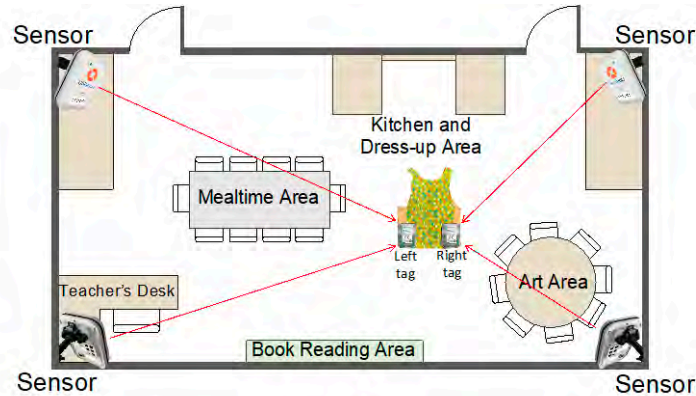


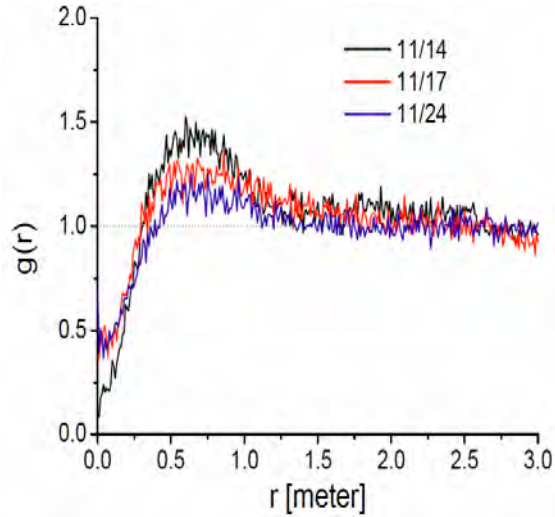
# Harnessing multimodal data to enhance machine learning of child vocalizations



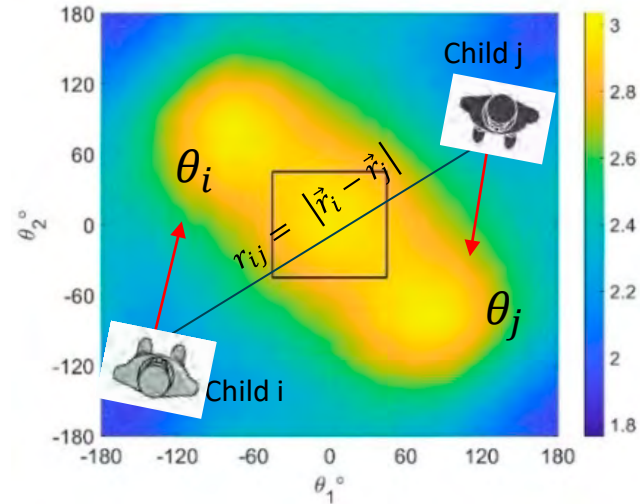
NIDCD Supplement R01DC018542 (MPI: Messenger & Perry)



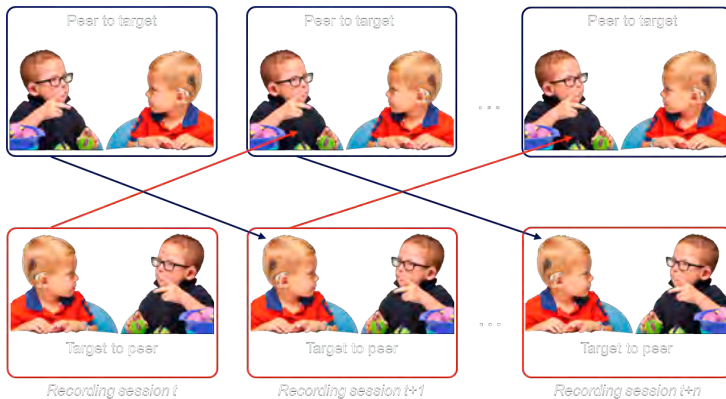
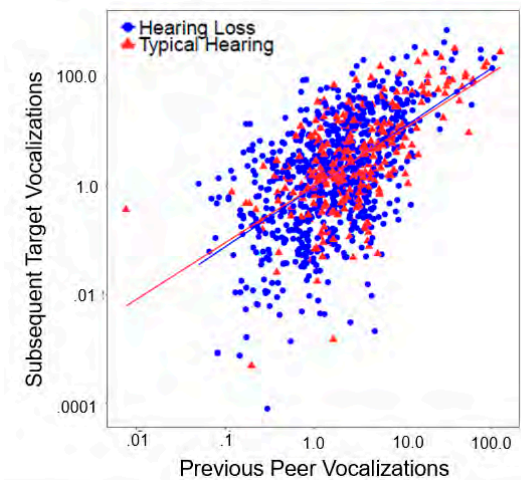
# Defining Social Contact



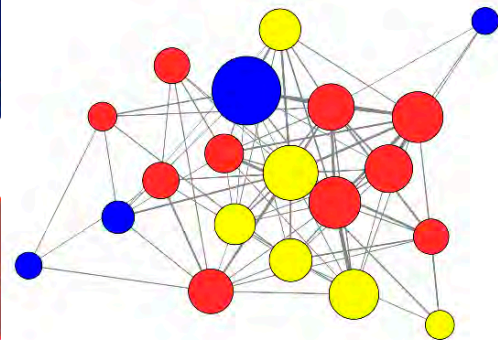
Proximity



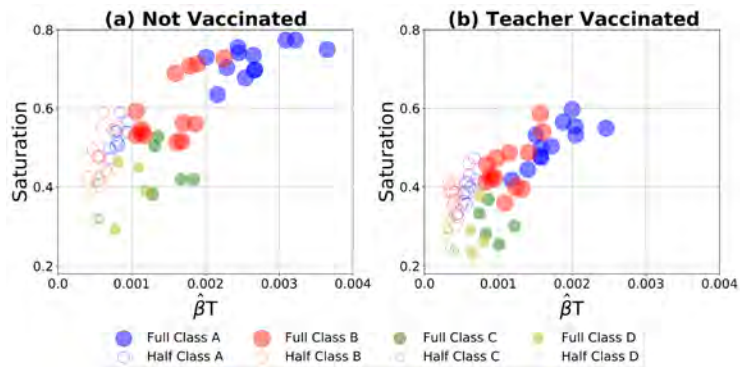
Mutual Orientation



Perry et al., 2022

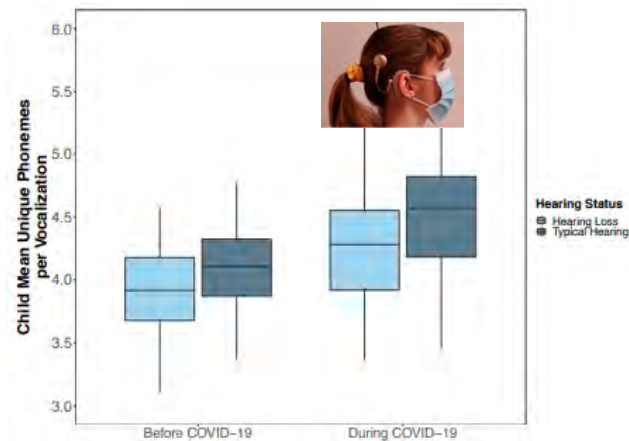


Fasano et al., 2021



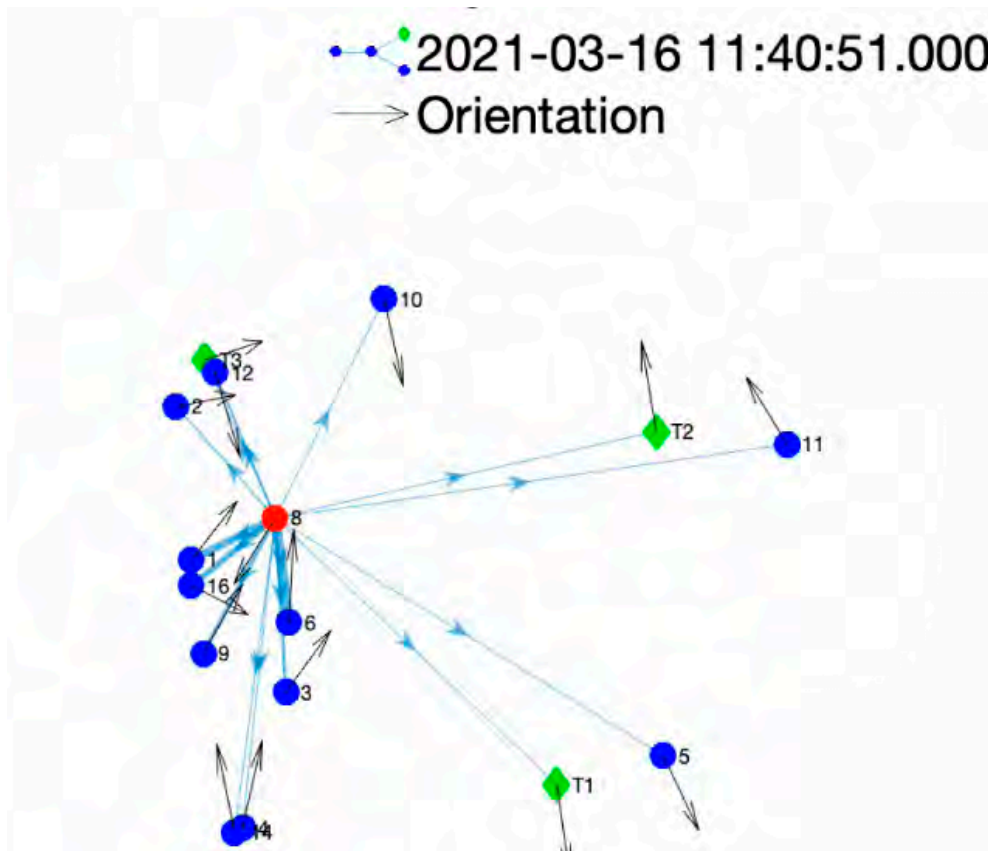
$$\bar{\beta} = (r_{ij}, \theta_i, \theta_j) = \beta_{max} \exp\left(-\frac{r_{ij}^2}{2\sigma_r^2} - \frac{\theta_i^2 + \theta_j^2}{2\sigma_\theta^2}\right) \exp(-\lambda t)$$

Zhang et al., 2022



Mitsven et al., 2022

# Visualizing *Continuous* Classroom Speech



# Quantifying who speech was directed to

$$w_{ij}(t) = \exp\left(-f_r(r_{ij}(t)) - f_\theta(\theta_{ij}(t)) - f_v(v_i(t))\right)$$

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Time	6						9				8	1			
261	37:02.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
262	37:03.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
263	37:03.1	0.268838	0.012672	0.180824	0.187801	0.007036	0.225388	0.587297	0.097926	0.149957	0.149613	0	0.292859	0.000607	0.003524	0.089452

Weighted outputs ( $r$ ,  $\theta$ ,  $v$ ) by child by time

# Dissemination

**Github:** Code and links to de-identified data

The screenshot shows a GitHub repository page for 'dmlabcode/UL\_Processor\_V2020'. The repository is a public template with 17 commits and 1 fork. The file list includes:

- UL\_Processor\_V2020 (Delete denoise.py, 4 months ago, 0 stars)
- .gitattributes (Add .gitignore and .gitattributes, 12 months ago, 1 watching)
- .gitignore (Add .gitignore and .gitattributes, 12 months ago, 1 fork)
- README\_DENOISE\_PYTHON\_CMD.txt (Add files via upload)
- README\_ULPROCESSOR.txt (Add files via upload)
- UL\_Processor\_V2020.sh (Add project files)

**Databrary:** Animated videos & example data

The screenshot shows a Databrary page for 'ML readiness supplement: Harnessing multimodal data to enhance machine learning of children's vocalizations'. The page includes a description of the dataset, how to cite it, and file release levels. The dataset description states: 'Data include 1) first person audio recordings of children and teachers in preschool classrooms for children with and without hearing loss, and 2) human annotation, and 3) automated estimation of speech and speaker diarization (child versus adult) from those recordings.' The citation is: 'Perry, L. & Messinger, D. (2021). Harnessing multimodal data to enhance machine learning of children's vocalizations. *Databrary*. Retrieved October 26, 2022 from <https://nyu.databrary.org/volume/1381>.' The file release levels table is as follows:

File Type	Release Level	# of Files
sessions	private	790
materials	private	1

**OSF:** De-identified data and analysis code for specific papers

The screenshot shows an OSF project page for 'Reciprocal Patterns of Peer Speech in P...'. The project is managed by Lynn K. Perry. The file list includes:

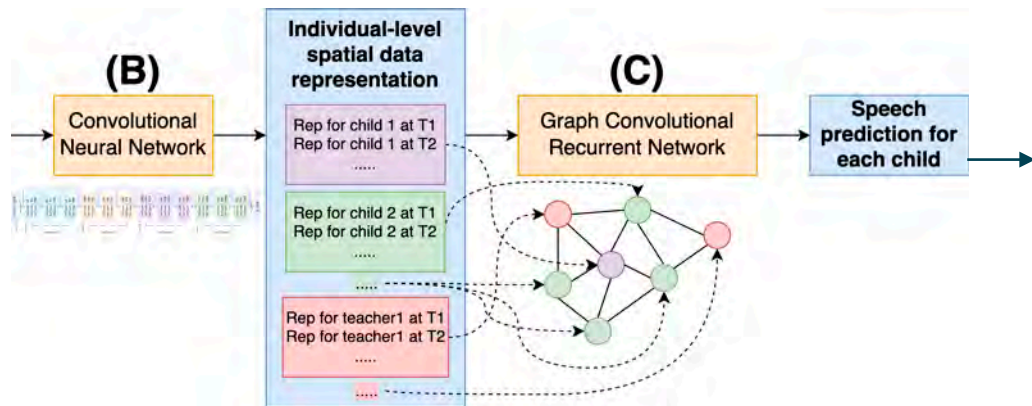
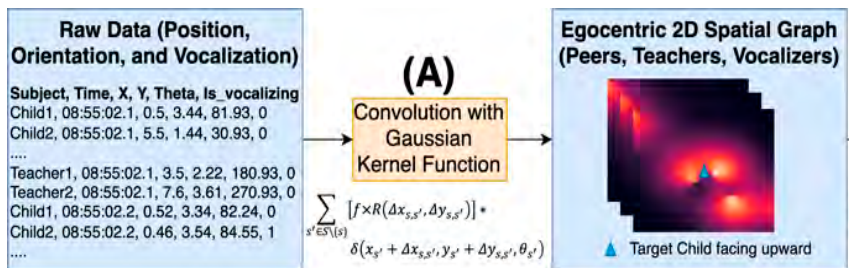
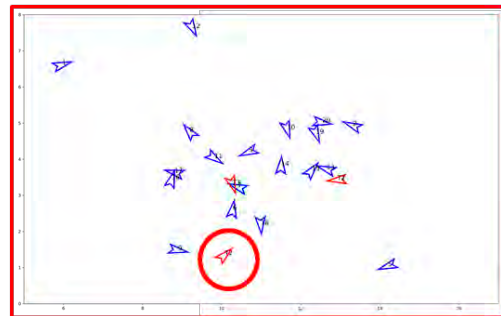
- Reciprocal Patterns of Peer Speech in Preschoo...
- OSF Storage (United States)
- ECRQ analyses.R (2020-03-28 12:56 PM)
- pairactivity\_all.csv (2020-03-28 12:56 PM)
- Participant characteristics.docx (2019-09-16 12:43 PM)
- peerLanguage\_grProximityData.csv (2019-08-14 01:21 PM)



# Next Steps: Machine learning vocalizations (test-driving the data)

Tao, Shyu, et al.,  
2022

A first-person perspective



Proof of Concept:  
 Predicting Vocalizations  
 (seconds per minute)

	Mean Observed	Mean Predicted	Mean Error % of Observed
Class A	2.33	2.53	21%
Class B	2.55	2.70	11%

# Peer Reviewed Publications

- Mitsven, S.G., Perry, L.K., Jerry, C.M., & Messinger, D.S. (2022) Classroom language during COVID-19: Associations between mask wearing and objectively measured teacher and preschooler vocalizations. *In press at Frontiers in Developmental Psychology.*
- Perry, L. K., Mitsven, S. G., Custode, S., Vitale, L., Laursen, B., Song, C., & Messinger, D. S. (2022). Reciprocal patterns of peer speech in preschoolers with and without hearing loss. *Early Childhood Research Quarterly*, 60, 201213. <https://doi.org/10.1016/j.ecresq.2022.02.003>
- Zhang, Y., Tao, Y., Shyu, M.-L., Perry, L. K., Warde, P. R., Messinger, D. S., & Song, C. (2022). Simulating COVID19 transmission from observed movement. *Scientific Reports*, 12(1), 3044. doi:10.1038/s41598-022-07043-4. [arXiv preprint arXiv:2108.07808](https://arxiv.org/abs/2108.07808).
- Mitsven, S.G., Perry, L. K., Tao, Y., Elbaum, B.E. Johnson, N. & Messinger, D. S. (2021). Objectively measured teacher and preschooler vocalizations: Phonemic diversity is associated with language abilities. *Developmental Science*. <https://doi.org/10.1111/desc.13177>.
- Fasano, R. M., Perry, L. K., Zhang, Y., Vitale, L., Wang, J., Song, C., & Messinger, D. S. (2021). A granular perspective on inclusion: Objectively measured interactions of preschoolers with and without autism. *Autism Research*. <https://doi.org/10.1002/aur.2526>.
- Altman, R. L., Laursen, B., Messinger, D. S., & Perry, L. K. (2020). Validation of continuous measures of peer social interaction with self- and teacher-reports of friendship and social engagement. *European Journal of Developmental Psychology*, 1-13. doi:10.1080/17405629.2020.1716724
- Messinger, D. S., E. B. Prince, M. Zheng, K. Martin, S. G. Mitsven, S. Huang, T. Stölzel, N. Johnson, U. Rudolph, L. K. Perry, B. Laursen & C. Song (2019). Continuous measurement of dynamic classroom social interactions. *International Journal of Behavioral Development*: 0165025418820708.
- Perry, L. K., Prince, E. B., Valtierra, A. M., Rivero-Fernandez, C., Ullery, M. A., Katz, L. F., Laursen, B., Messinger, D. S. (2018). A year in words: The dynamics and consequences of language experiences in an intervention classroom. *PLoS ONE*, 13(7), e0199893. doi:10.1371/journal.pone.0199893



# Thanks!



Questions?



Daniel Messinger  
[dmessinger@miami.edu](mailto:dmessinger@miami.edu)



National Institute on  
Deafness and Other  
Communication Disorders

Lynn Perry  
[lkperry@miami.edu](mailto:lkperry@miami.edu)