Neurodevelopmental Sensitivity to Context: Socioeconomic Status, Frontolimbic Structure, & Affect Recognition in Preschool Children

Marguerite Knudtson, MS,
Kelly Barry, MS,
Johanna Bick, PhD

Department of Psychology, University of Houston

Introduction

- Affect Recognition (AR) is a foundational socioemotional skill that develops rapidly during the preschool years and supports later functioning (Sun et al., 2025; Wolf et al., 2021).
- AR development is supported by frontolimbic functioning involved in emotion processing (Leisman et al., 2025)
- Socioeconomic status (SES) has been consistently associated with children's socioemotional development (Bradley & Corwyn 2002).
- However, little is known about how neurodevelopment interacts with SES to influence early AR.

Present Study

- This study examines whether (1) age, SES, and frontolimbic brain structure uniquely predict AR in preschool-aged children when modeled together, and (2) whether frontolimbic structure moderates the association between SES and AR.

Hypotheses

1. Age and SES will be positively associated with AR in multivariate models
2. Variation in frontolimbic architecture will moderate SES-AR associations

Methods

Table 1. *Sample Characteristics*

Variable	Value
N	66
Age (yrs)	M: 5.11 (SD: 0.97), Range: 3 - 6
Sex	32 (48%) female
INR	M: 1.46 (SD: 1.12), Range: 0.23 - 3.81
AR (% correct)	M: 0.62 (SD: 0.16), Range: 0.31 - 1.0
Race	48.5% White; 18.2% Other; 13.6% Black; 10.6% Biracial; 9.1% Asian
Ethnicity	44 (67%) Hispanic

Measures

Affect Recognition NEPSY-II Affect Recognition subtest (Korkman, et al., 2007)

- Scored as % correct of administered items

Socioeconomic Status Continuous income-to-needs ratio (INR; McLoyd, 1998)

Neuroimaging Metrics

- MRI – T1 weighted images, averaged across right and left hemispheres, processed with iBEAT V2.0 (Wang et al., 2023): Volume, surface area, cortical thickness, curvature, convexity, vertex count
- ROIs: mOFC, lOFC, rACC, cACC, amygdala, hippocampus

Analytic Plan

- Multivariate linear regression & moderation models:
  - AR ~ Age + INR + ROI metric + Sex + ICV
  - AR ~ INR * ROI metric + Age + Sex + ICV
- FDR correction within cortical (2 ROIs) and subcortical (6 ROIs) families.

Results

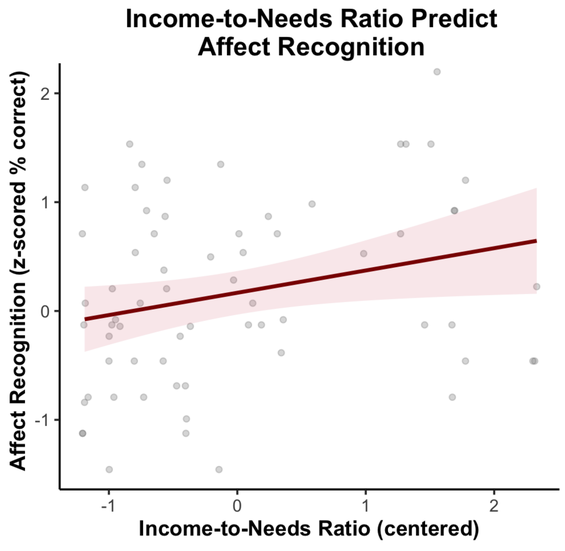
Aim 1: Unique Predictors of Affect Recognition

- INR significantly positively predicted AR across all combined models.
- Age was not significant in combined models (trend level in select models)
- No ROI metric showed a unique main effect controlling for INR and age

Table 2. *INR Shows Consistent Association with AR across Multivariate Frontolimbic Models*

Predictor	Significant in n models (%)	Range of b (all models)	Range of p values (all models)
Age	0 (0%)	0.16 - 0.19	0.09 - 0.15
INR	28 (100%)	0.24 - 0.27	0.005 - 0.01

Note *. b = unstandardized regression coefficient. Each model included age, income-to-needs ratio (INR), and one ROI metric. 28 total models. Covariates: sex, intracranial volume. Significance defined as p < 0.05 (uncorrected)*



Note. *Shaded band reflects 95% confidence interval*

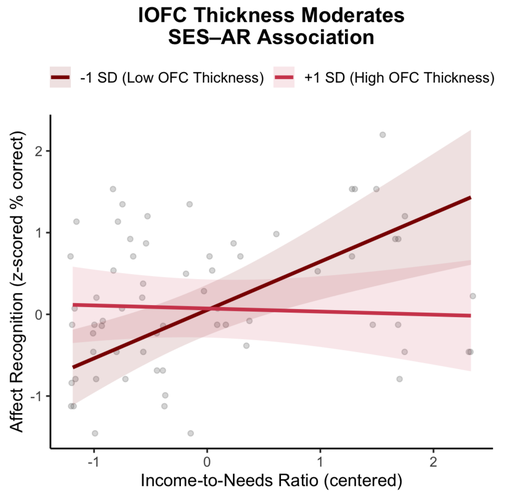
Aim 2: Frontolimbic Moderation of SES Effects on Affect Recognition

- OFC thickness and hippocampal structure showed moderation trends
- Thinner OFC / smaller hippocampi → stronger positive INR-AR association
- Moderation effects did not survive FDR corrections.

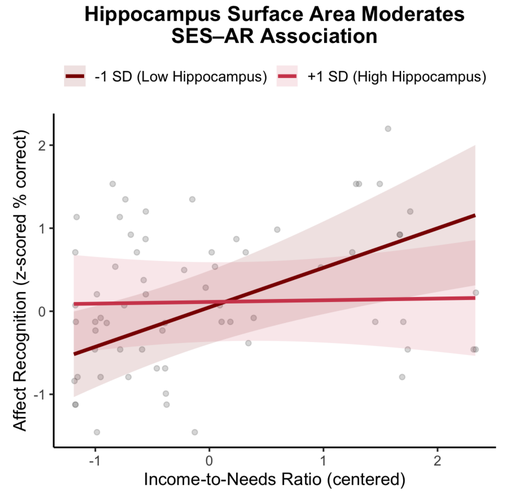
Table 3. *Frontolimbic Moderation of INR - AR Effect*

Predictor	b	p	FDR Adj. p
OFC Thickness			
INR x lOFC Thickness	-0.29	0.003**	0.07
INR x mOFC Thickness	-0.20	0.03*	0.42
Hippocampus			
INR x Hippocampus Vol.	-0.2	0.04*	0.09
INR x Hippocampus SA	-0.23	0.02*	0.08

Note *:* b = unstandardized regression coefficient. Covariates: age, sex, intracranial volume. FDR corrections were applied within cortical (24 interactions) and subcortical (4 interactions) families.



Note. *Shaded band reflects 95% confidence interval*



Note. *Shaded band reflects 95% confidence interval*

Discussion

- Findings suggest that early AR reflects socioeconomic context, even when accounting for age and frontolimbic structure.
- INR was a consistent independent predictor of AR across models, highlighting the importance of integrating social determinants of health into pediatric neuropsychological assessment and interpretation (Ursache & Noble, 2016).
- Preliminary evidence for moderation of INR-AR associations by OFC thickness (mOFC, lOFC) and hippocampal structure (volume, surface area) suggests that frontolimbic neurodevelopment may play a role in modulating children's sensitivity to socioeconomic context during early socioemotional development.
- The specificity of OFC *thickness* moderation effects may reflect neural pruning and specialization processes that increase children's dependence on environmental inputs for AR development
- These patterns are consistent with differential susceptibility models and extend them to neural architecture in early childhood (Belsky & Pluess, 2009; Boyce & Ellis, 2005).
- Lower AR performance may reflect modifiable contextual factors and learning opportunities, highlighting targets for intervention

Limitations & Future Directions

- Moderation effects should be interpreted cautiously as they did not survive FDR correction.
- Future work should use larger samples with broader SES coverage and longitudinal designs to clarify how frontolimbic development relates to sensitivity to SES across childhood
- Future studies should also test whether SES-related differences in AR predict real-world socioemotional functioning, and whether interventions and resource access could alter trajectories

References

- Belsky, J., & Pluess, M. (2009). Beyond diathesis stress: Differential susceptibility to environmental influences. *Psychological Bulletin*, *135*(6), 885–908. https://doi.org/10.1037/a0017376
- BOYCE, W. T., & ELLIS, B. J. (2005). Biological sensitivity to context: I. an evolutionary–developmental theory of the origins and functions of stress reactivity. *Development and Psychopathology*, *17*(02). https://doi.org/10.1017/s0954579405050145
- Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology*, *53*(1), 371–399. https://doi.org/10.1146/annurev.psych.53.100901.135233
- Ellis, B. J., Boyce, W. T., Belsky, J., Bakermans-Kranenburg, M. J., & van Ijzendoorn, M. H. (2011). Differential susceptibility to the environment: An evolutionary–neurodevelopmental theory. *Development and Psychopathology*, *23*(1), 7–28. https://doi.org/10.1017/s0954579410000611
- Korkman, M., Kirk, U., & Kemp, S. (2007). Nepsy - second edition. *PsycTESTS Dataset*. https://doi.org/10.1037/t15125-000
- Leisman, G., Alfasi, R., & D'Angiulli, A. (2025). Emotional brain development: Neurobiological indicators from fetus through toddlerhood. *Brain Sciences*, *15*(8), 846. https://doi.org/10.3390/brainsci15080846
- McLoyd, V. C. (1998). Socioeconomic disadvantage and child development. *American Psychologist*, *53*(2), 185–204. https://doi.org/10.1037/0003-066x.53.2.185
- Sun, T., Lei, P.-W., DiPerna, J. C., Hart, S. C., Zhao, H., & Husmann, K. (2025). Association between social-emotional behaviors and academic outcomes in primary school students: A person-centered approach. *School Mental Health*, *17*(3), 980–994. https://doi.org/10.1007/s12310-025-09787-6
- Ursache, A., & Noble, K. G. (2016). Socioeconomic status, white matter, and executive function in children. *Brain and Behavior*, *6*(10). https://doi.org/10.1002/brb3.531
- Wang, L., Wu, Z., Chen, L., Sun, Y., Lin, W., & Li, G. (2023). iBEAT v2.0: A multisite-applicable, deep learning-based pipeline for infant cerebral cortical surface reconstruction. *Nature Protocols*, *18*(5), 1488–1509. https://doi.org/10.1038/s41596-023-00806-x
- Wolf, S. (2020). Trajectories of social-emotional development across preschool and Early Primary School. *Proceedings of the 2020 AERA Annual Meeting*. https://doi.org/10.3102/1570798

Legend: *AR = Affect Recognition; SES = Socioeconomic Status; INR = Income-to-Needs Ratio; ROI = Region of Interest; mOFC = Medial Orbitofrontal Cortex; lOFC = Lateral Orbitofrontal Cortex; rACC = Rostral Anterior Cingulate Cortex; cACC = Caudal Anterior Cingulate Cortex; ICV = Intracranial Volume*