From parent to child: Neural transmission across generations during language comprehension

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Introduction

❖ **Intergenerational transmission (IGT)**
- Greater similarity: Related parent-child > unrelated adult-child pairs
- Significance: Child development across domains (e.g., language)
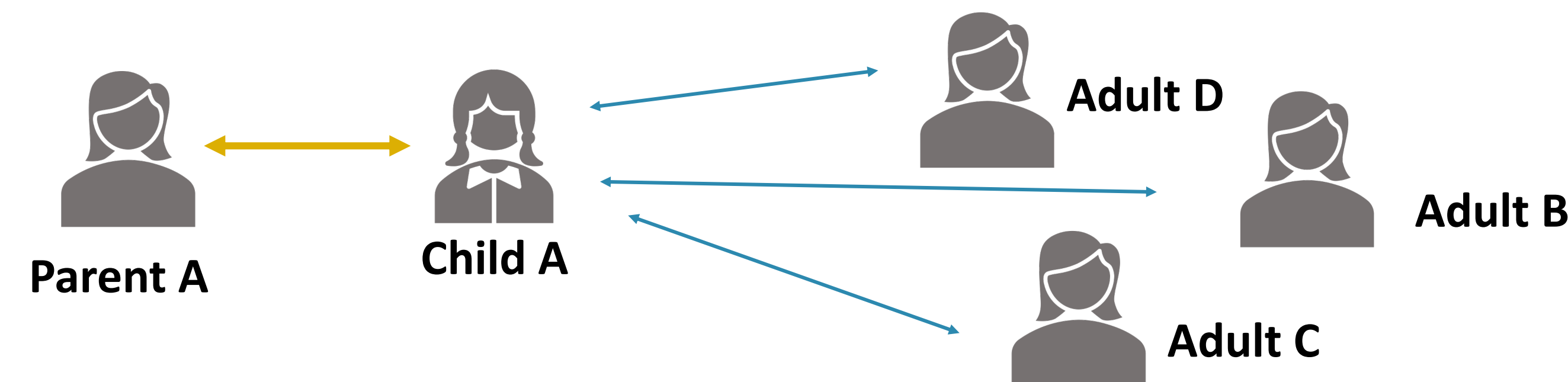
❖ **Current gaps in IGT**
- Behavior and brain Structure (Yamagata et al., 2016)
- Brain function?
- Behavior-brain association?

❖ **Ongoing discussions**
- Functional specificity (Cosmides & Tooby, 1994)
- Right-hemisphere dominance during child development (Chiron et al., 1997; Olulade et al., 2020)
- Maternal vs. paternal IGT (Yamagata et al., 2016)
- Shared environment vs. genes: twin design

❖ **Research questions**
- To which extent is a child's brain function similar to that of the parents?
- Does neural IGT 1) support the view of functional specificity? 2) reflect asymmetry in brain maturation? 3) differ between mother–child and father–child pairs?
- Is neural IGT associated with behavioral IGT?
- Do shared environmental or genetic factors contribute to neural IGT?
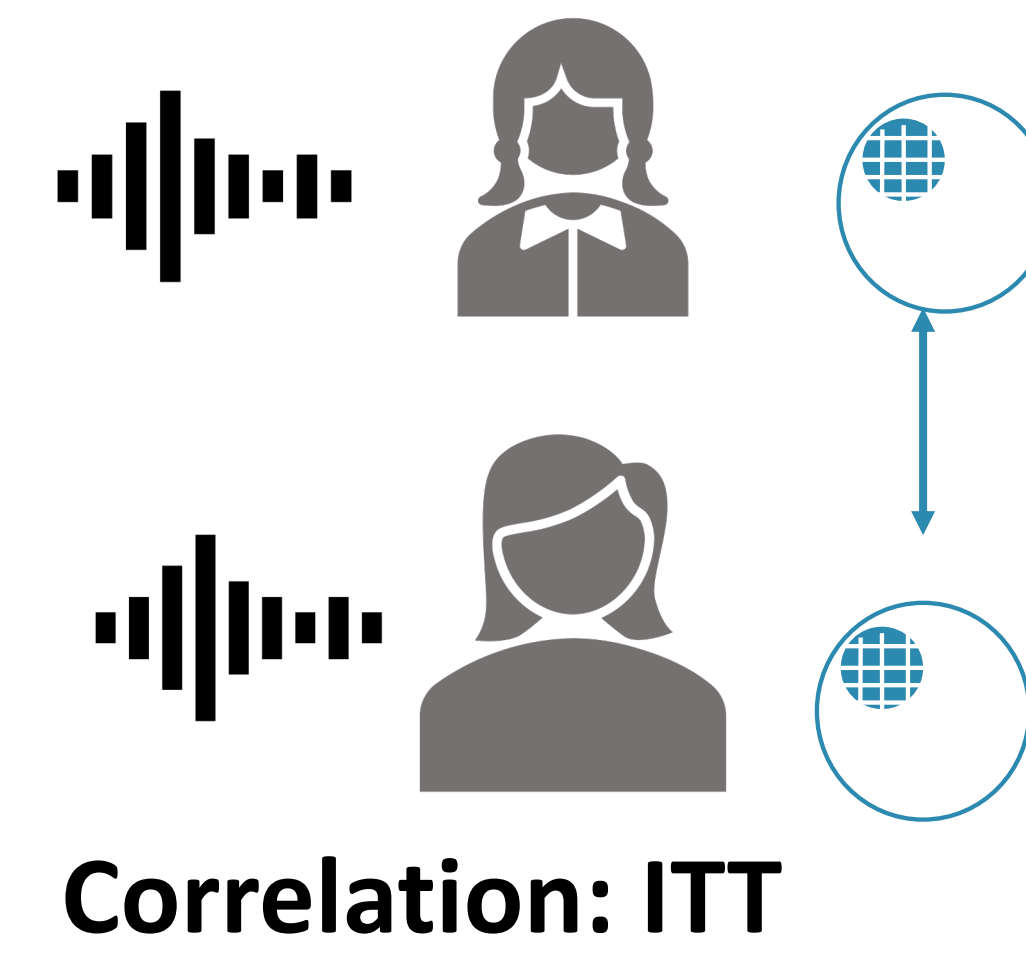
Methods

❖ **Participants**

	N	Age	Sex
Children	54	9.65y (*SD*: 1.64; range: 7-13y)	23 Female
Adults (mothers and fathers)	90	45.32y (*SD*: 4.62; range: 37.58-58.75y)	45 Female

❖ **In-MRI Task**
- 8 short auditory stories across two runs (Binder et al., 2011)

❖ **Language assessments**
- Oral comprehension, vocabulary, and passage comprehension

❖ **HCP dataset**
- 101 Monozygotic and 73 dizygotic twins

❖ **Neural IGT**
- Similarity in multivariate patterns for related parent-child and unrelated adult-child pairs

Correlation: ITT

❖ **Cortical networks**

Language network   Auditory network

Control network   Dorsal attention network (DAN)   Ventral attention network (VAN)
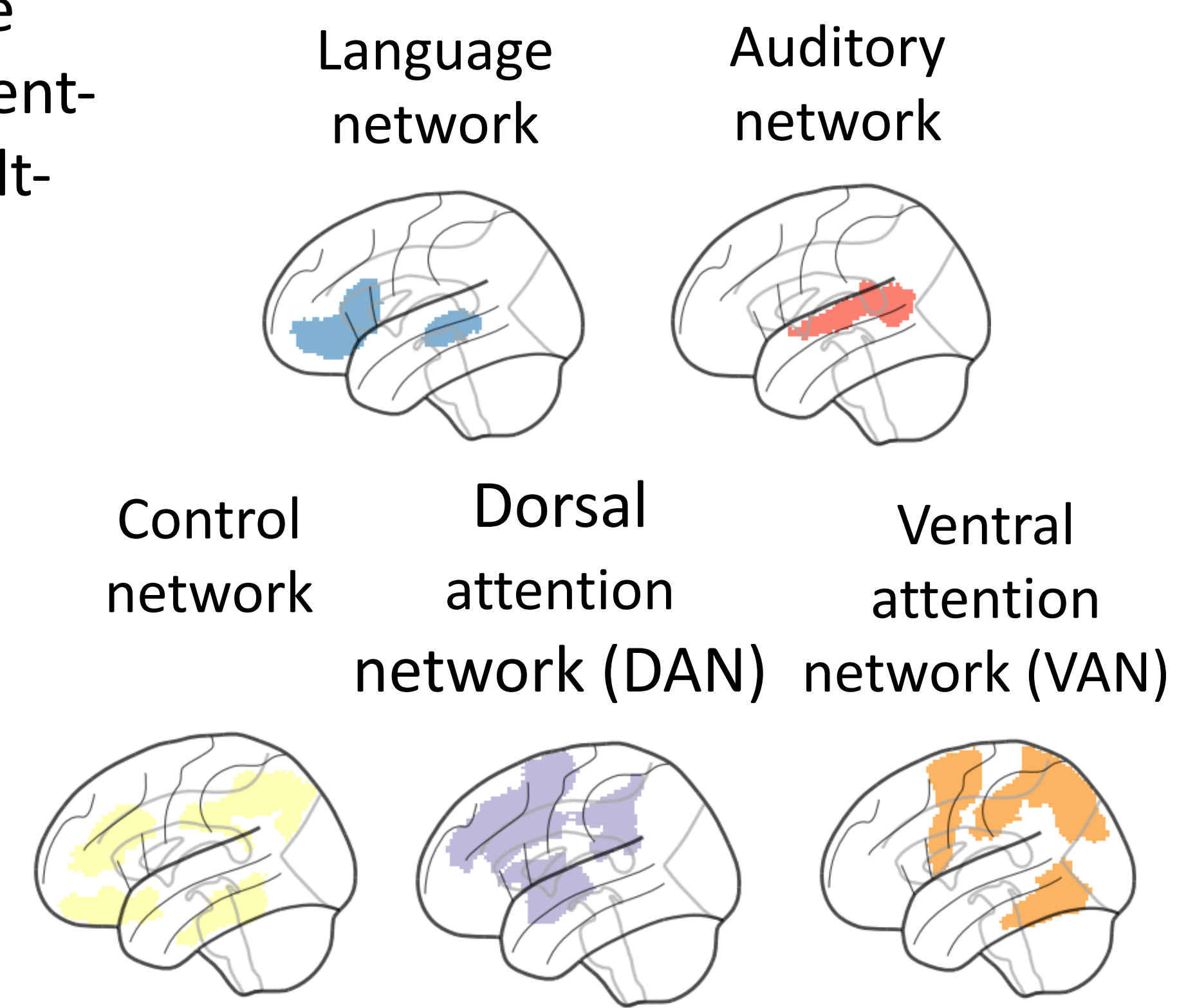
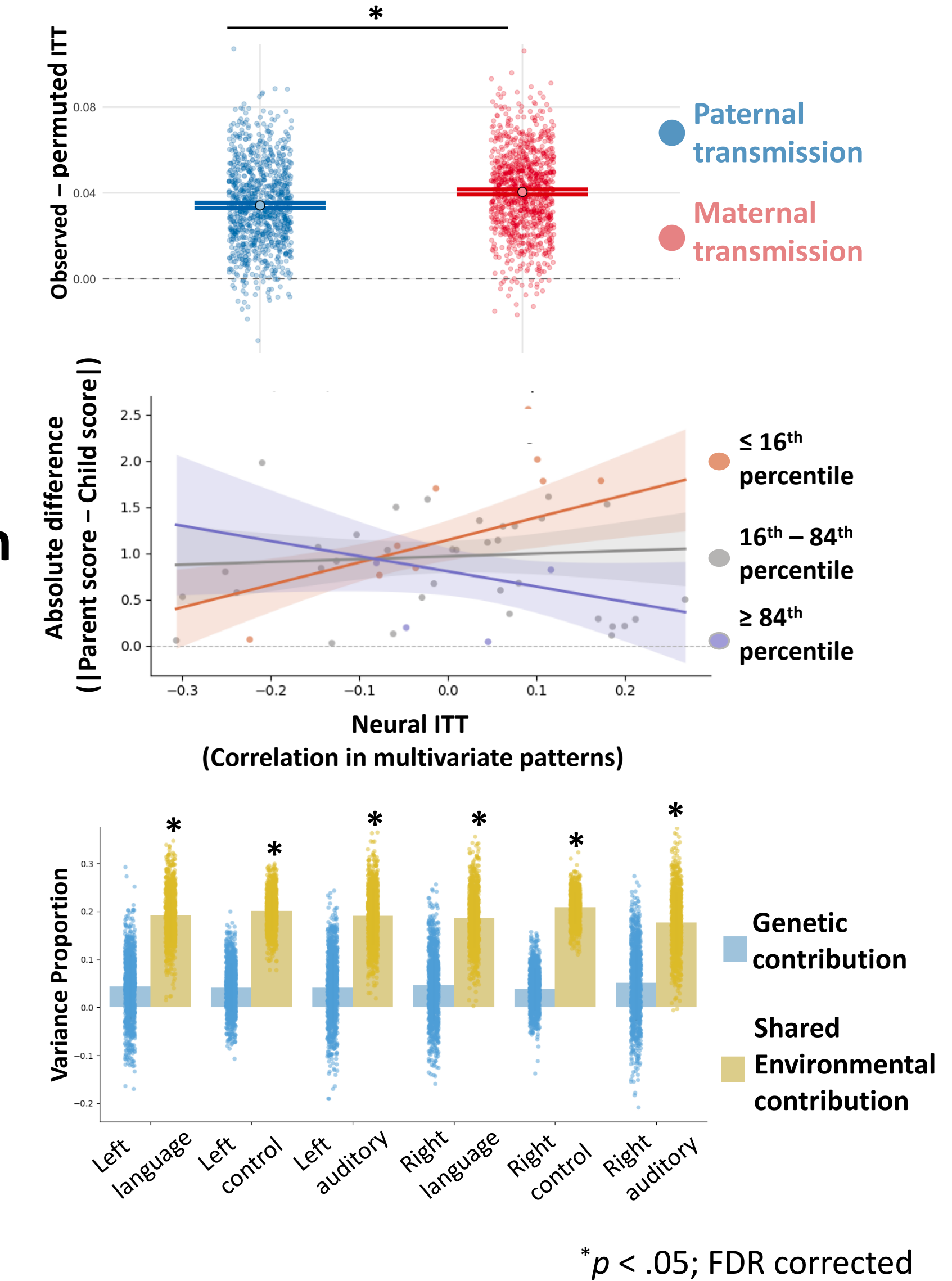Illustration shown for *Left hemisphere* (Schaefer et al., 2018)

❖ **Statistical analyses**
- **Permutation tests**
  - Related parent-child vs. unrelated adult-child pairs
- **Linear Mixed-Effects Models (LMM)**
- **Moderation models**
  - Parental language skill as a moderator

Results

❖ **Behavioral IGT across Language skills**
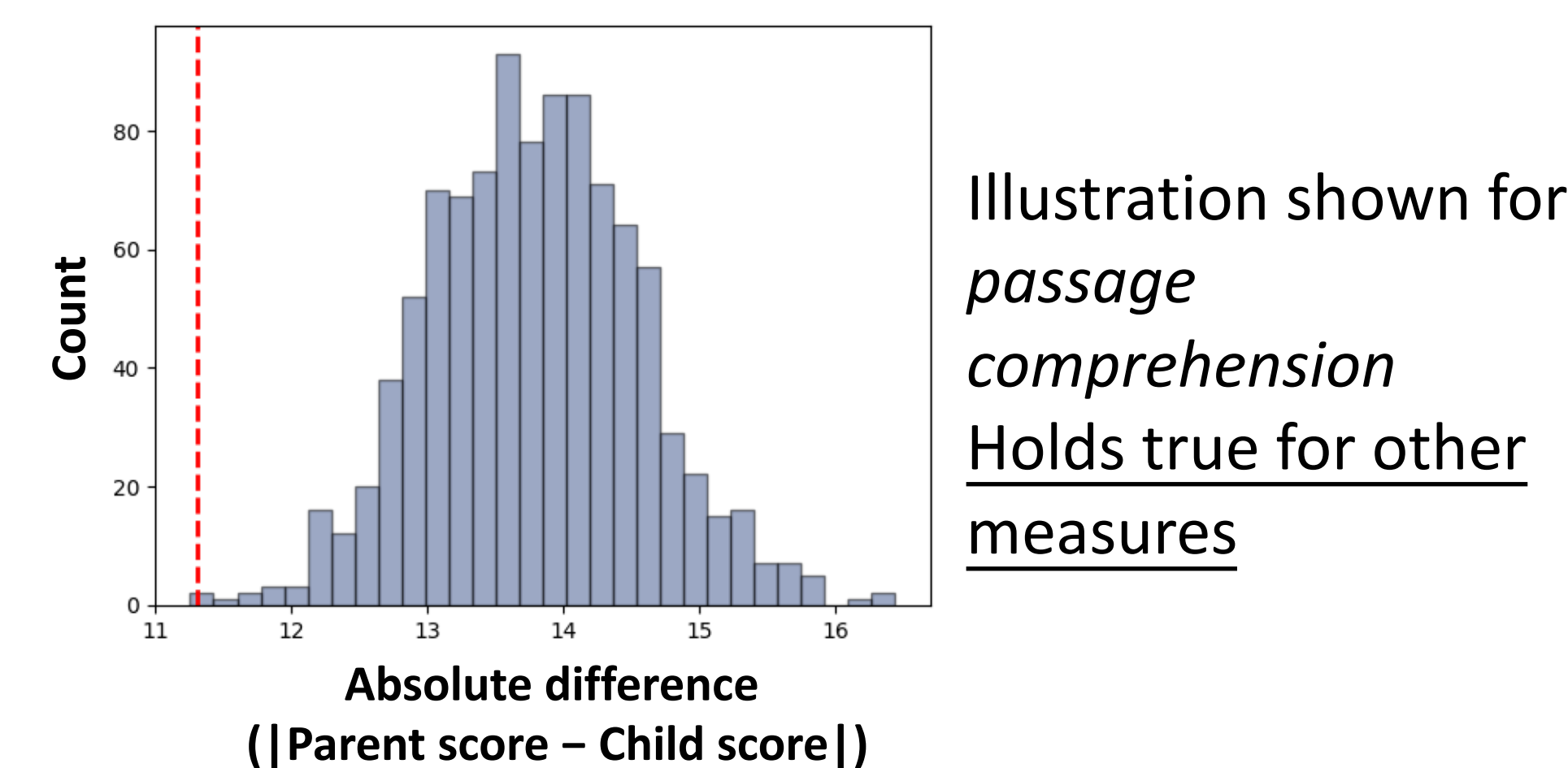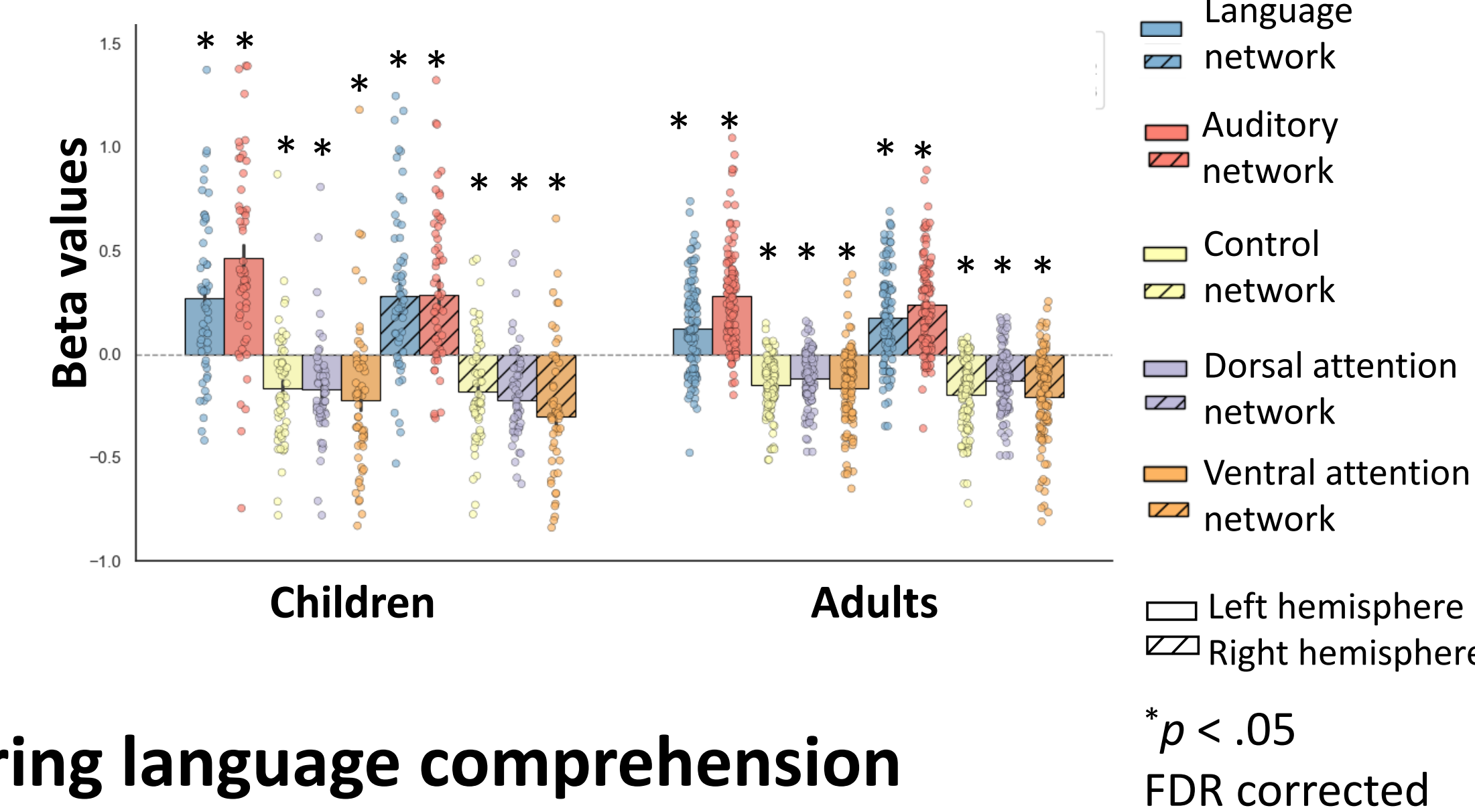- Distance: **Related** < **Unrelated pairs**

Illustration shown for *passage comprehension*
Holds true for other measures

❖ **Recruitment of the language and auditory network during story listening**

*p < .05 FDR corrected

❖ **Greater IGT in the right hemisphere during language comprehension**

2. Neural IGT: **Related** > **Unrelated pairs**

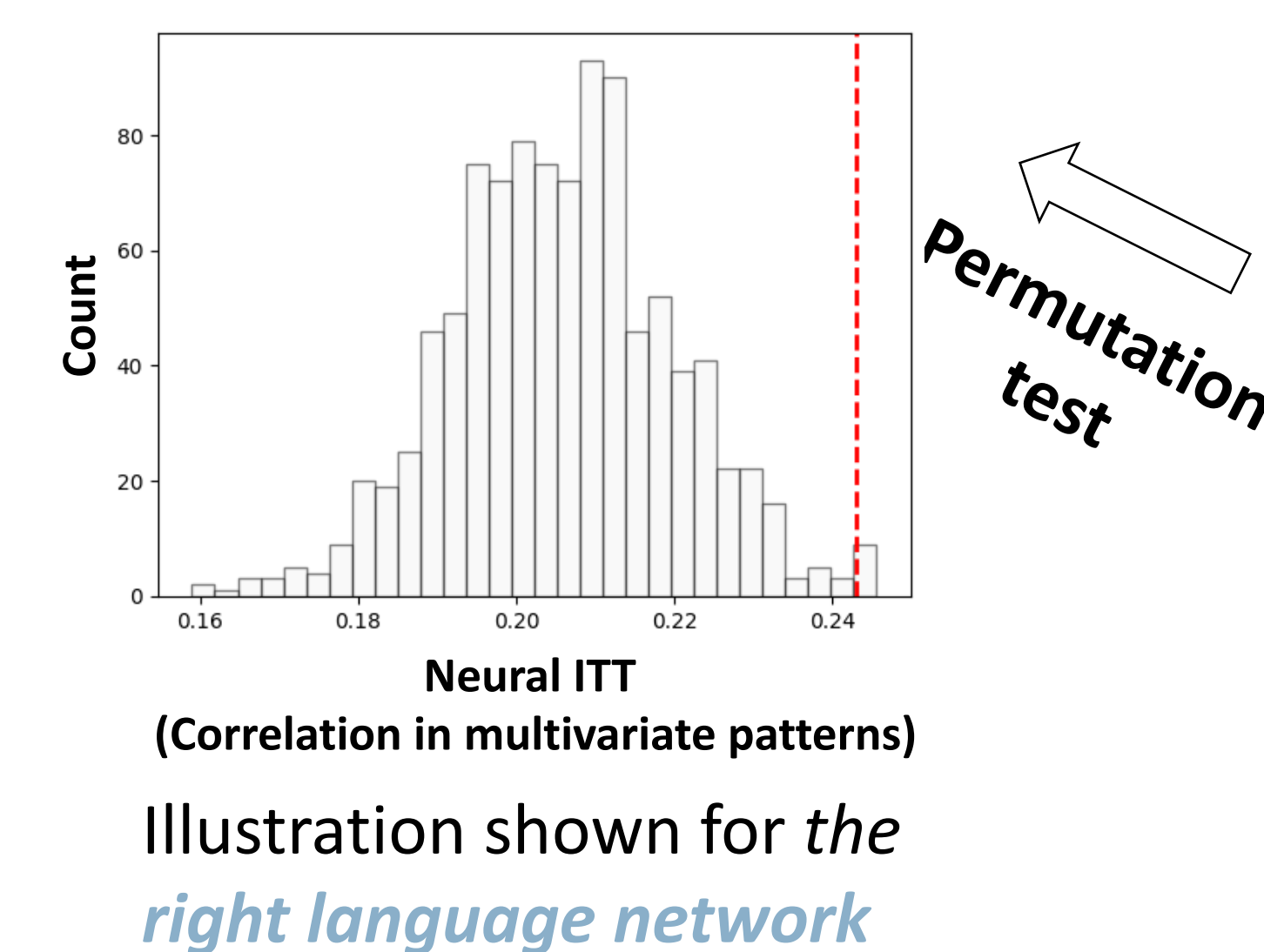

Illustration shown for *the right language network*

1. Parent–Offspring IGT by Network and Hemisphere

3. Network × Hemisphere

Hemisphere — Left — Right

+p < .07; *p < .05; FDR corrected

❖ **Greater maternal** transmission in the right language network

❖ **Mother's vocabulary moderates behavior-brain transmission** in the right control network

❖ **Shared environment drives** neural similarity among family members (From the HCP twin dataset)
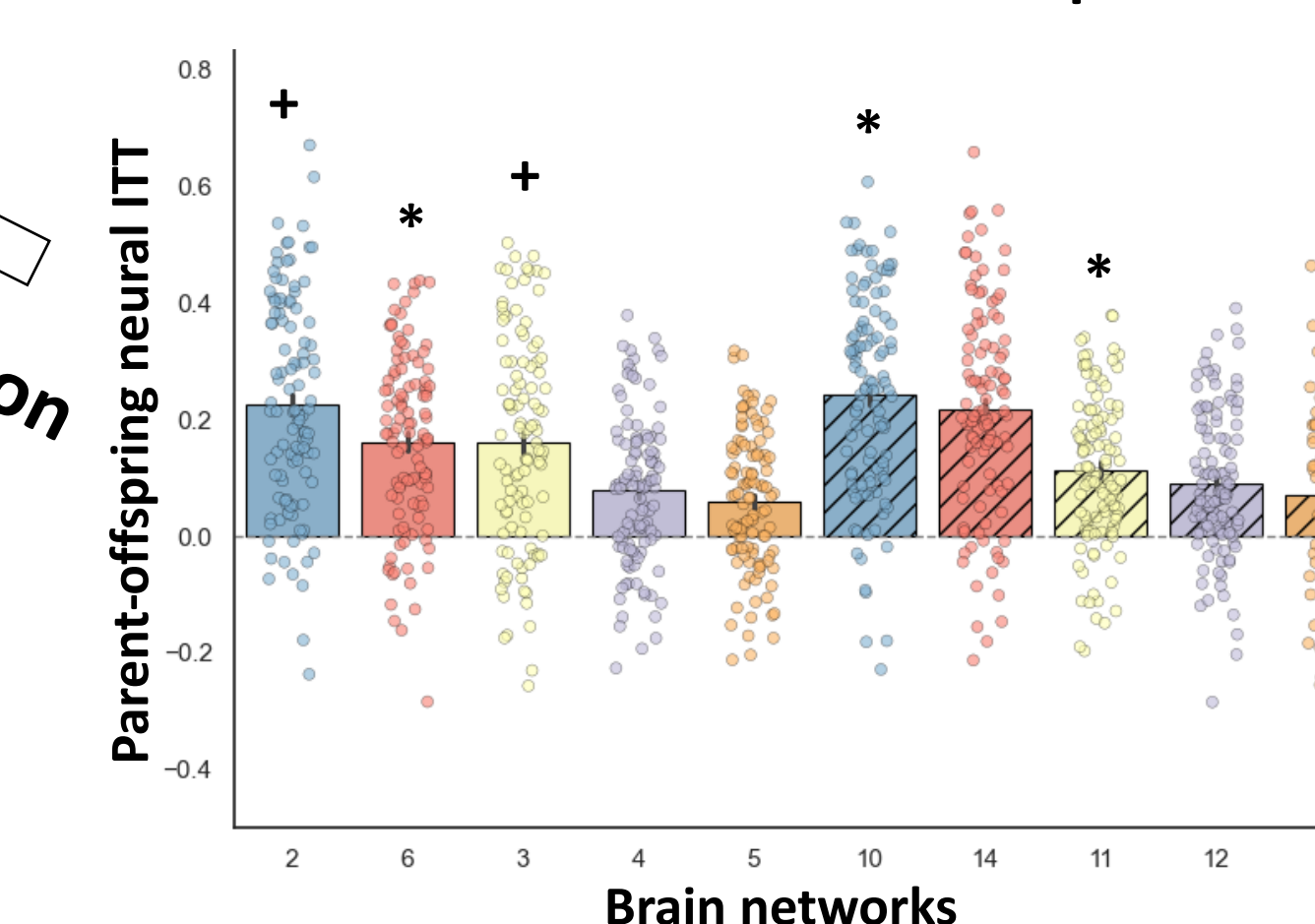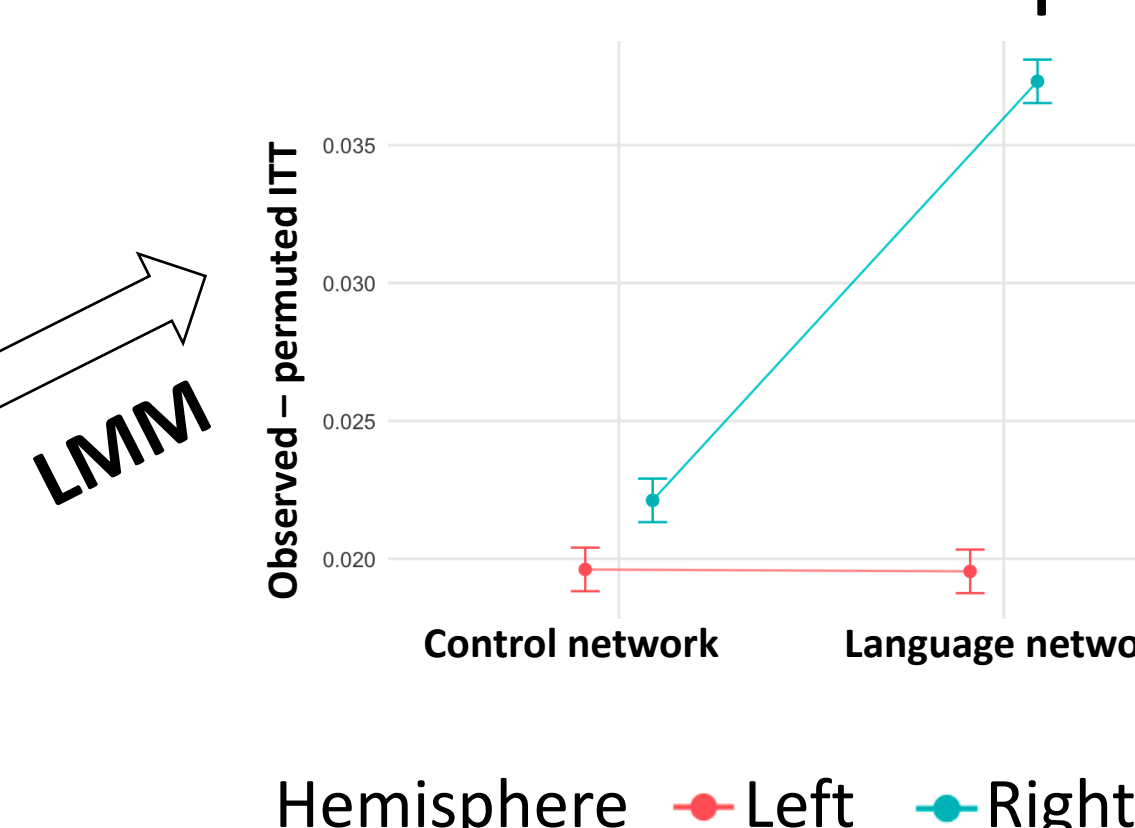
*p < .05; FDR corrected

Conclusion

This study provides evidence for neural transmission from parents to offspring during language comprehension. Specifically, it shows:

❖ **Functional specificity:** Neural transmission is most prominent in the language network.

❖ **Hemispheric asymmetry:** Neural transmission is greater in the right hemisphere, suggesting that it plays a stronger role in transmitting familial neural similarity at this developmental stage.

❖ **Parent-of-origin effect:** Neural transmission differs by parental gender, with greater mother–offspring transmission, possibly due to more shared environment.

❖ **Behavior-brain association:** Maternal language skills moderate the association between behavioral and neural transmission.

❖ **Twin study:** Shared environment, rather than genetics, drives neural similarity among family members. Although based on adults, this finding supports our view that greater shared environment contributes to stronger maternal transmission.

References
Binder, J. R., Gross, W. L., Allendorfer, J. B., Bonilha, L., Chapin, J., Edwards, J. C., ... & Weaver, K. E. (2011). Mapping anterior temporal lobe language areas with fMRI: a multicenter normative study. *Neuroimage*, 54(2), 1465-1475.
Cosmides, L., & Tooby, J. (1994). Origins of domain specificity: The evolution of functional organization. *Mapping the mind: Domain specificity in cognition and culture*, 853116.
Chiron, C., Jambaque, I., Nabbout, R., Lounes, R., Syrota, A., & Dulac, O. (1997). The right brain hemisphere is dominant in human infants. *Brain: a journal of neurology*, 120(6), 1057-1065.
Olulade, O. A., Seydell-Greenwald, A., Chambers, C. E., Turkeltaub, P. E., Dromerick, A. W., Berl, M. M., ... & Newport, E. L. (2020). The neural basis of language development: Changes in lateralization over age. *Proceedings of the National Academy of Sciences*, 117(38), 23477-23483.
Schaefer, A., Kong, R., Gordon, E. M., Laumann, T. O., Zuo, X. N., Holmes, A. J., ... & Yeo, B. T. (2018). Local-global parcellation of the human cerebral cortex from intrinsic functional connectivity MRI. *Cerebral cortex*, 28(9), 3095-3114.
Yamagata, B., Murayama, K., Black, J. M., Hancock, R., Mimura, M., Yang, T. T., ... & Hoeft, F. (2016). Female-specific intergenerational transmission patterns of the human corticolimbic circuitry. *Journal of Neuroscience*, 36(4), 1254-1260.