Neural mechanisms underlying the income-achievement gap: the role of the ventral visual stream

Maya L. Rosen[1,2], Kelly A. Sambrook[3], Andrew N. Meltzoff[2], Katie A. McLaughlin[1]

[1]Harvard University, Department of Psychology; [2]University of Washington, Department of Psychology; [3]University of Washington, Department of Radiology

BACKGROUND

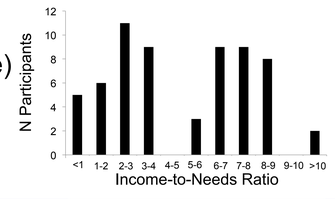
- Childhood socioeconomic status (SES) is associated with differences in both brain structure and function and that these differences may contribute to the income-achievement gap.[1-4]
- Research on SES and neurodevelopment has focused largely on the neural networks that support these complex cognitive functions
- Many studies have also found SES-related differences in the structure and function of the ventral visual stream[1-5] (VVS)—a set of brain regions involved in processing visual stimuli
- We recently proposed that development of the VVS may be influenced by environmental experiences common among children from low-SES families[6]
- These functional differences in VVS may contribute to SES-related differences in cognitive and academic abilities[6]

PRESENT STUDY

- We hypothesized that SES-related differences in VVS recruitment during attention would contribute to the SES-achievement gap.
- We used two tasks that require coordination between visual processing and top-down control: cued attention—the ability to use an external visual cue to direct attention to a specific location in the environment, and memory-guided attention—which requires using past experience to direct attention. Both of are associated with academic performance in children.

SAMPLE

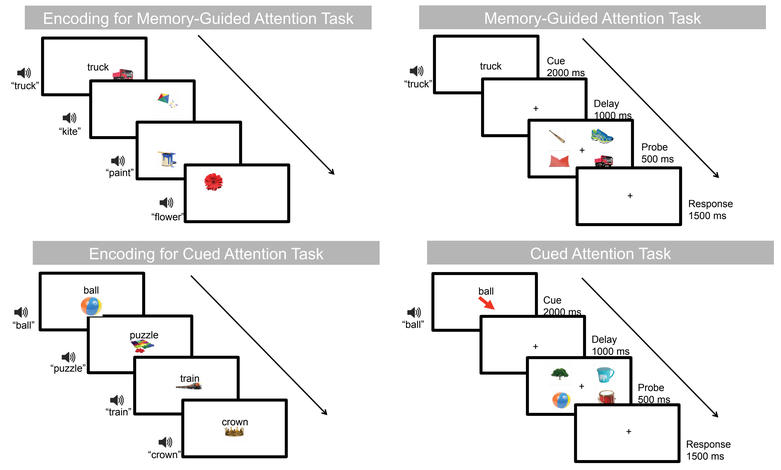
- 62 children aged 72 – 96 months (Mean = 84.5, SD = 4.5, 31 female)
- SES was assessed using log income-to-needs ratio
- Control for age, sex, and violence



FUNDING

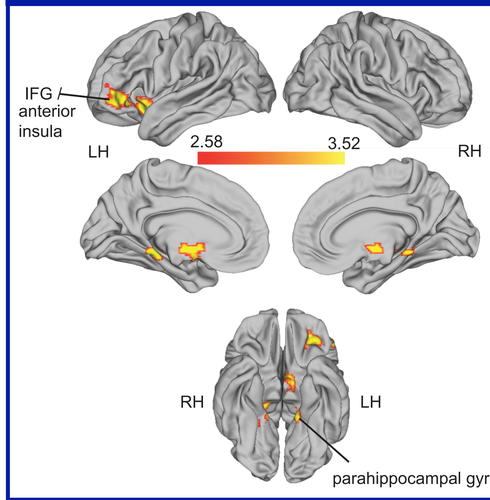
This work was supported by the National Institute of Child Health and Human Development at the National Institute of Health [F32 HD089514 to MR], National Institute of Mental Health at the National Institutes of Health [R01-MH103291 and R01-MH106482 to KM, the Brain and Behavior Foundation NARSAD Early Investigator Award, an Early Career Research Fellowship from the Jacobs Foundation, and the IMHRO Rising Star Award to KM and the Bezos Family Foundation.

TASKS AND PARAMETERS



3T Phillips Achieva; 32 channel head coil; 2000 ms TR; 32 3 mm slices; Blocked design; Only include correct trials

POSITIVE ASSOCIATIONS BETWEEN SES AND ACTIVATION DURING CUED ATTENTION



- Region of interest analysis additionally revealed a positive association between SES and recruitment of the left fusiform gyrus during cued attention(B = 0.294, *p* = .031), but not the right (B = 0.151, *p* = .179).
- There were no significant associations between SES and lateral occipital cortex activation during cued attention (ps > .3)
- No significant associations between SES and activation during memory-guided attention

REFERENCES

1.Finn, A. S., Minas, J. E., Leonard, J. A., Mackey, A. P., Salvatore, J., Goetz, C., … Gabrieli, J. D. E. (2016). Functional brain organization of working memory in adolescents varies in relation to family income and academic achievement. *Developmental Science*, 20(5). 1–15.

2. Mackey, A. P., Finn, A. S., Leonard, J. A., Jacoby-Senghor, D. S., West, M. R., Gabrieli, C. F. O., & Gabrieli, J. D. E. (2015). Neuroanatomical correlates of the income-achievement gap. *Psychological Science*, *26*(6), 925–933.

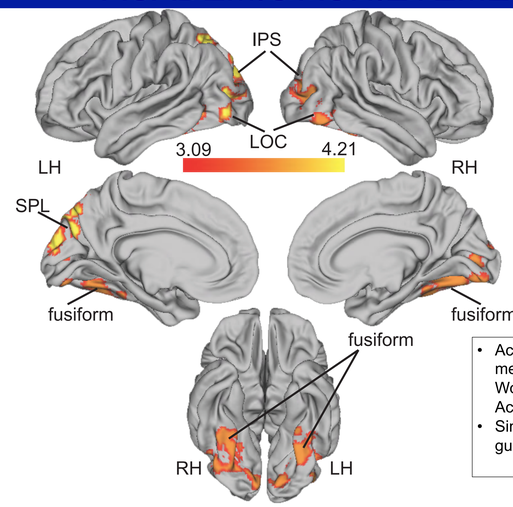
3. Noble, K. G., Houston, S. M., Brito, N. H., Bartsch, H., Kan, E., Kuperman, J. M., … Sowell, E. R. (2015). Family income, parental education and brain structure in children and adolescents. *Nature Neuroscience*, *18*(5), 773–778.

4. Rosen, M.L., Sheridan, M. A., Sambrook, K. A., Meltzoff, A. N., & McLaughlin, K. A. (2018). Socioeconomic disparities in academic achievement: A multi-modal investigation of neural mechanisms in children and adolescents. *NeuroImage*, *173*, 298–310

5.Leonard, J. A., Romeo, R. R., Park, A. T., Takada, M. E., Robinson, S. T., Grotzinger, H., … Mackey, A. P. (2019). Associations between cortical thickness and reasoning differ by socioeconomic status in development. *Developmental Cognitive Neuroscience*.

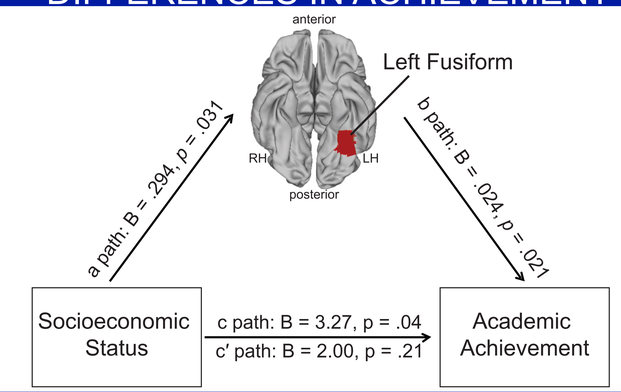
6. Rosen, M. L., Amso, D., & McLaughlin, K. A. (2019). The role of the visual association cortex in scaffolding prefrontal cortex development: A novel mechanism linking socioeconomic status and executive function. *Developmental Cognitive Neuroscience*. *39*, 100699

VVS RECRUITMENT DURING CUED ATTENTION IS ASSOCIATED WITH HIGHER ACADEMIC ACHIEVEMENT



- Academic achievement measured with the Woodcock-Johnson Academic Skills Cluster
- Similar pattern for memory-guided attention

VVS RECRUITMENT DURING CUED ATTTENTION MEDIATES SES-RELATED DIFFERENCES IN ACHIEVEMENT



CONCLUSIONS

These findings extend previous work by highlighting that
(i) early-developing visual processing regions play an important role in supporting complex attentional processes,
(ii) the development of these regions is influenced by SES
(iii) individual differences in VVS function may be an additional neural mechanism in the income-achievement gap.