Socio-economic status and HME relate to children's neural response to digits

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INTRODUCTION

Background

- ✓ Math knowledge in children is characterized by inter-individual differences that persist through most school years.
- ✓ Socio-economic status (SES) and home math environment (HME) contribute to variations in children's math development [1], but little is known about their neural correlates.

The present study

Aims to test whether family environment - indexed by SES and HME - may affect IPS areas supporting the processing of numerical information in 8-year-olds

METHOD

Participants

- ✓ 47 children and one of their parents (87% mothers)

Procedure

- ✓ Children and parents tested in the lab during 2 sessions

Materials

Behavioral

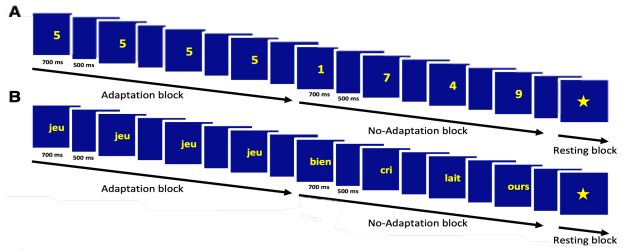
Child

- ✓ Standardized Math fluency (WJ-III)
- ✓ IQ (NEMI-2)

Parent :

- ✓ Standardized Math fluency (WJ-III)
- ✓ Questionnaire assessing SES, beliefs and expectations towards math, and home math practices (adapted from Lefevre et al. 2009)

Neuro-imaging : Adaptation task (from Perrachione et al. 2016)



- ✓ Neural adaptation effect = Activity associated with blocks of different stimuli (no-adaptation) > activity associated with blocks of identical stimuli (adaptation)
- ✓ Assesses brain sensitivity to the presentation of numerical (digits) and non-numerical information (words)

ANALYSIS STRATEGY

- ✓ Math activities were broken down into (i) basic vs. advanced [2] and (ii) formal (i.e., explicitly didactic activities) vs. informal (i.e., informal opportunities such as cooking or playing board games) [3].
- ✓ For each subject and task, the neural adaptation effect was measured.
- ✓ Math fluency scores were regressed against neural adaptation effects, separately for each task.
- ✓ T-maps were thresholded at a FWE-corrected threshold of $p < .05$ across the whole brain, using the non-parametric permutation-based TFCE method (Smith & Nichols, 2009)
- ✓ ROI analyses examined brain activity associated with SES and HME in bilateral IPS regions related to math fluency scores.

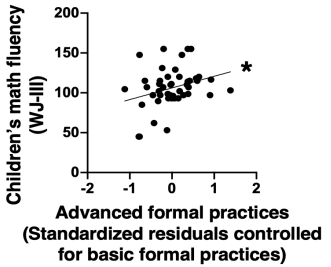
References and funding:

1. Elliott, L., & Bachman, H. J. (2018). Child Development Perspectives, 12(1), 16-21.
2. Skwarchuk, S.-L. (2009). Early Childhood Education Journal, 37(3), 189-197.
3. Sénéchal, M., & LeFevre, J.-A. (2002). Child Development, 73(2), 445-460.

RESULTS

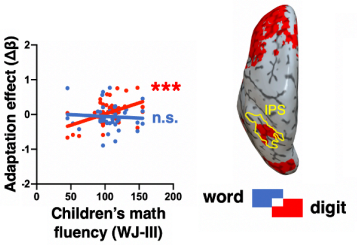
Behavior

- ✓ Children's math fluency was positively related to the frequency of advanced formal practices (r = .30, p = .021), but not SES.
- ✓ This relation was found over and above (i) parental education and income, (ii) parents' math fluency scores, and (iii) children's IQ (all ßs > 13.29, all *ps* < .044).

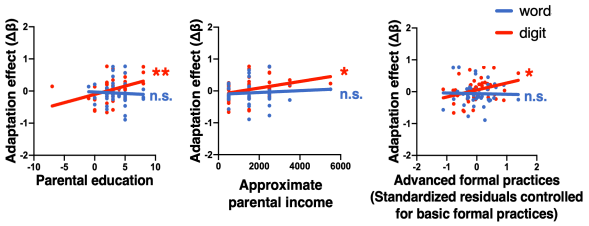


Neuroimaging

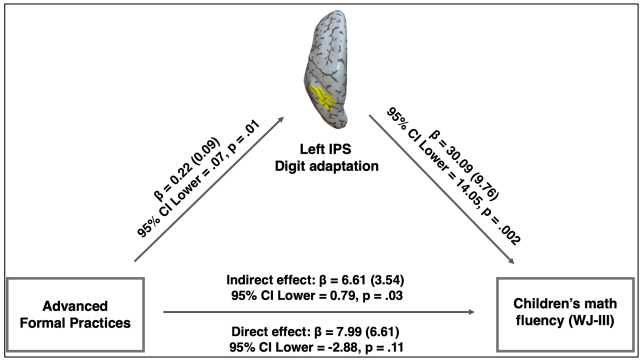
- ✓ Children's math fluency was positively related to digit adaptation effects (but not words) in the left IPS (r = .47, p < .001)



- ✓ Digit (not word) adaptation effect was related SES and HME in the left IPS (education: r = .39, p = .003; income: r = .33, p = .011 ; HME: r = .32, p = .013).



- ✓ The relation between HME and math fluency scores was fully mediated by the digit adaptation effect in the left IPS



CONCLUSION

- ✓ Higher SES and better HME were associated with better math skills in French children from 2nd and 3rd grade
- ✓ Higher SES and better HME were also associated with enhanced brain sensitivity to numerical information
- ✓ The HME might affect children's math skills by impacting the response to symbolic numerical information in the IPS.