

Examining the Factor Structure of the Home Mathematics Environment to Delineate Its Role in Predicting Preschool Numeracy, Math Language, and Spatial Skills

Background

- Research demonstrates that the home mathematics environment (HME) is a significant predictor of children's broad mathematics skills (e.g., numeracy, geometric reasoning, and spatial skills). However, few studies have formally examined and contrasted if there are distinct aspects of the HME that are important for a preschool-age population.
- Additionally, the relation between mathematical language, an important foundation for early numeracy development, and the HME has not previously been investigated.
- The current study replicates and extends previous research by examining the relation between the factor structure of the HME and direct assessments of preschoolers' numeracy, mathematical language, and spatial skills.

Research Questions

In the current study, we aimed to:

- 1) Examine the measurement structure of the HME with a preschool-aged sample.
- 2) Examine the role of the HME in predicting direct assessments of preschoolers' numeracy, mathematical language, and spatial skills.

Participants

Participants were recruited from 18 early childhood centers.

- 129 parent participants
 - 44.2% less than a college degree, 28.7% reporting a 2- or 4-year degree, 27.2% reporting a graduate degree
- 129 child participants
 - Age: 3.07-6.03 ($M = 4.71$, $SD = 0.55$)
 - 46.5% Female
 - 79.1% White/Caucasian, 2.3% Black/African American, 4.7% Latino/Hispanic, 4.7% Asian, 7.0% other/multiracial, 2.3% did not report race/ethnicity

Measures

Parent survey:

- Home Math Environment (HME) – 24 items categorized as direct numeracy (10 items), indirect numeracy (7 items) and spatial activities (7 items).
 - "In the past month, how often did you and your child engage in the following activities?" (0 = never, 1 = a few times per month, 2 = a few times per week, 3 = every day, 4 = multiple times a day; e.g., count objects, build with blocks)

Child assessments:

- Preschool Early Numeracy Skills Screener (PENS-B)
- Preschool Assessment of the Language of Mathematics (PALM)
- Spatial transformation task

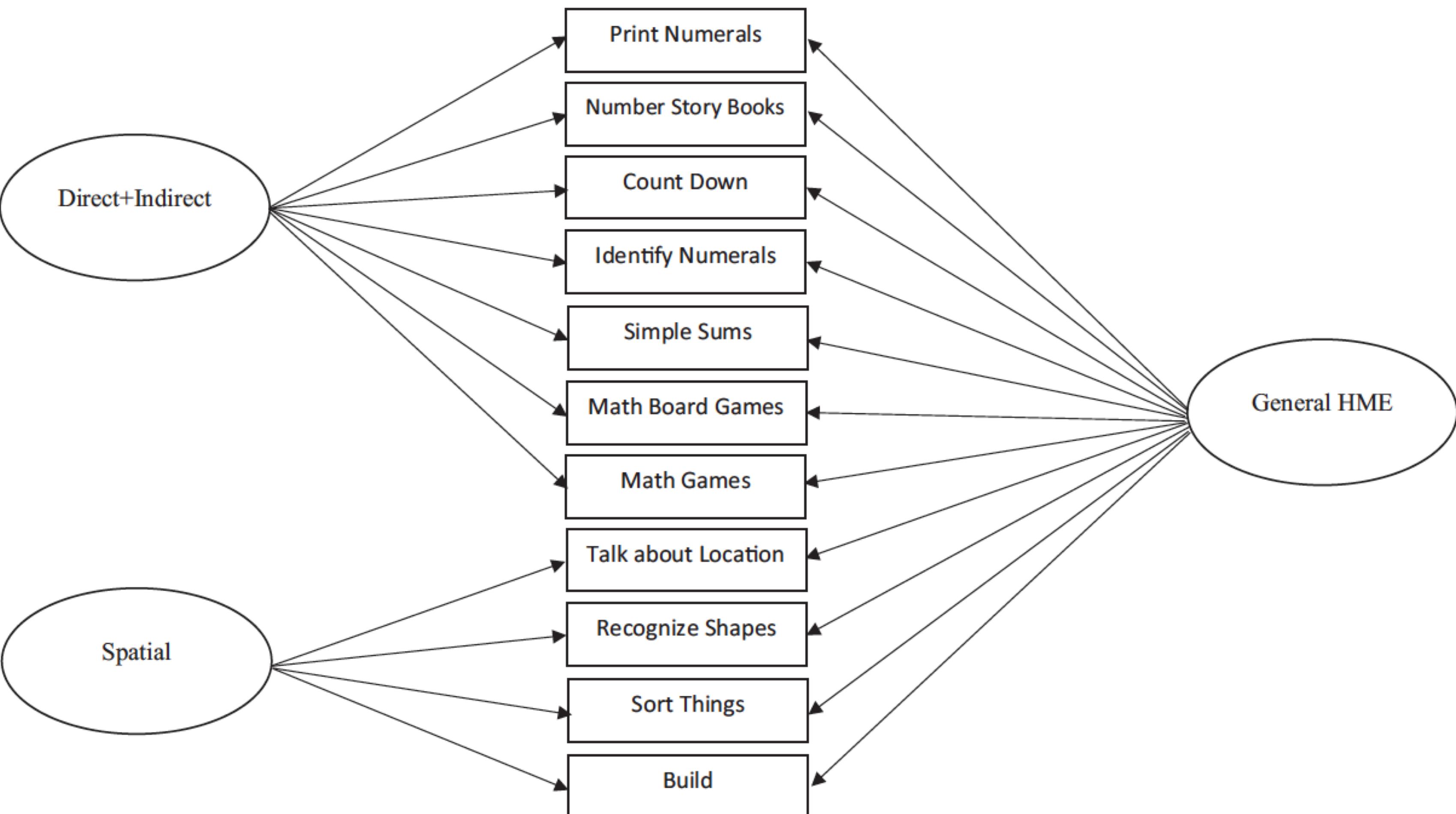


Figure 1. Best-fitting model, the final 2-factor bifactor model (direct + indirect numeracy, spatial, and a general home mathematics environment [HME] factor).

Table 1. Correlations between final latent home mathematics environment factors and direct assessments of children's math skills.

	1	2	3	4	5	6
1. Direct + indirect numeracy	—					
2. Spatial	0.00	—				
3. HME	0.00	0.00	—			
4. Numeracy skills	0.36***	0.00	-0.20*	—		
5. Mathematical language	0.36***	0.04	-0.21*	0.61***	—	
6. Spatial skills	0.25**	0.13	0.01	0.45***	0.27***	—

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.01$.

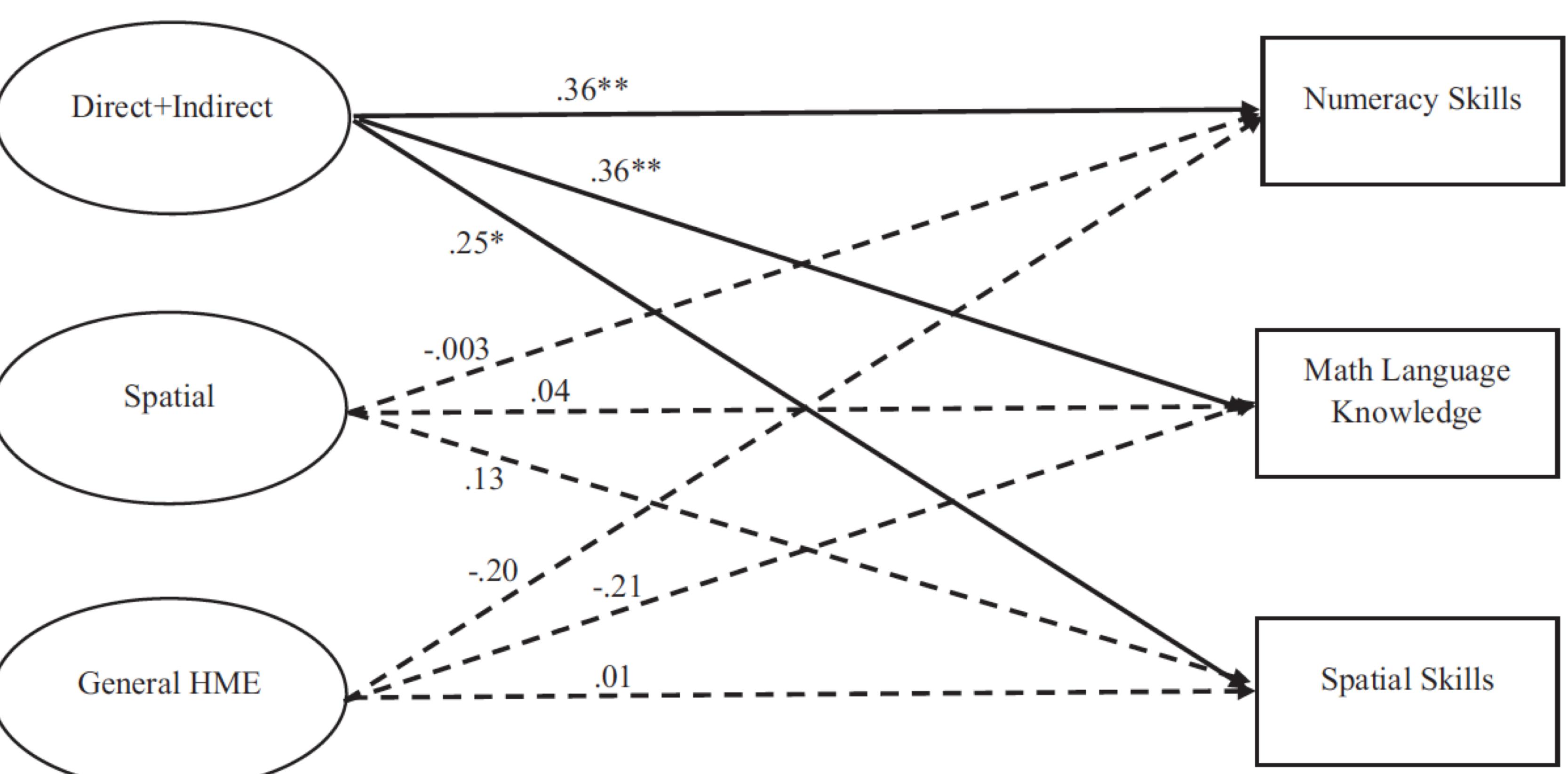


Figure 2. Relations between home numeracy environment factors and direct assessments of children's numeracy skills, mathematical language knowledge, and spatial skills. Standardized coefficients are presented in the figure. * $p < 0.05$, ** $p < 0.01$.

Results

- The best fitting model was a 2-factor bifactor model including 11 items (seven on the direct + indirect numeracy factor and four on the spatial factor; $\chi^2 = 51.53$, $df = 33$, $p = .02$, CFI = .95 , TLI = .92 , RMSEA = .07).
- Factor loadings per factor were from .29 - .70 (direct + indirect factor), .23 - .72 (spatial factor), and .18 - .69 (general HME factor).
- Only the direct + indirect numeracy factor significantly predicted child performance on numeracy ($\beta = 0.36$, $p = 0.004$), mathematical language ($\beta = 0.36$, $p = 0.001$), and spatial skills ($\beta = 0.25$, $p = 0.022$), while controlling for age, sex, and parent education (CFI = .91, TLI = .87, RMSEA = .07, SRMR = .07).

Discussion

- In contrast to previous research finding a 3-factor bifactor model (general HME, direct numeracy, indirect numeracy, and spatial), we found that a 2-factor bifactor model (general HME, direct + indirect numeracy, and spatial) was the more parsimonious model.
- Additionally, previous research suggests that the general HME factor was the aspect of the HME that was related to parent reports of children's mathematics performance, but we found that the direct + indirect numeracy factor was the only aspect of the HME that was related to direct assessments of preschooler's numeracy, mathematical language, and spatial skills.
- Results highlight the importance of parent-child engagement in specific aspects of mathematics-related activities.
- Future research should use longitudinal data to test the directionality of the association between the HME and children's mathematics skills.

Acknowledgments

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