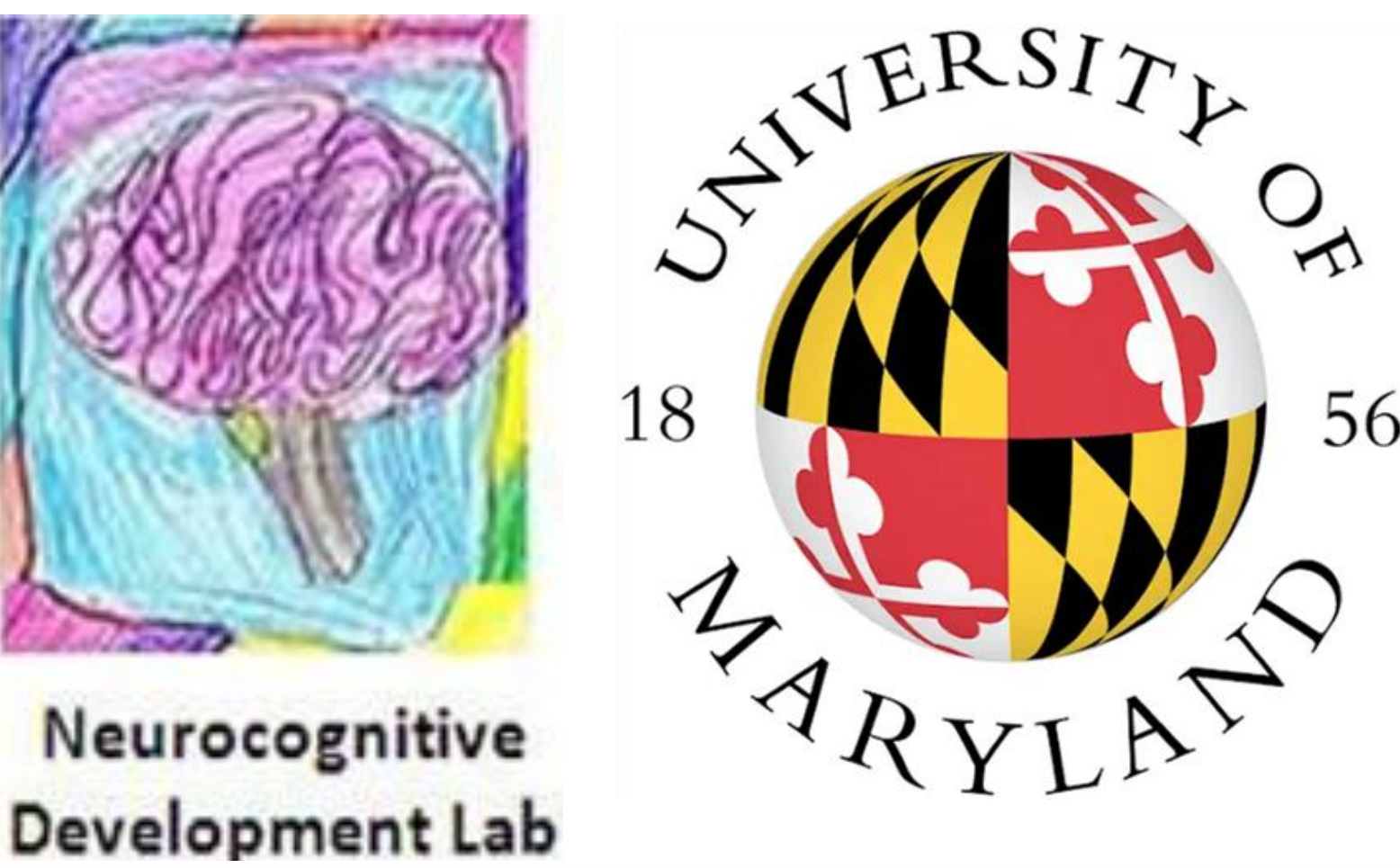


Why some children struggle to remember: The role of attention difficulties and hippocampal subfield volumes in preschoolers' memory performance

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INTRODUCTION

- Episodic memory is the encoding, storing, and retrieval of information¹.
- The hippocampus is crucial for memory formation and recall^{2,3}.
- Some of its subfields encompass CA1, CA2, CA3, CA4, and DG.
- While some studies have shown larger hippocampal volumes are associated with better memory in children⁴, other studies have challenged the “bigger is better” assumption⁵.
- Attention difficulties are associated with memory deficits in preschoolers⁶, correlated with poorer memory⁷, and linked to smaller hippocampal volumes⁸.
- However, links between hippocampal subfield volumes, attention problems, and memory in preschoolers remain unclear.
- Objective:** To examine the relations between episodic memory, parent-rated attention difficulties, and hippocampal subfield volumes in preschoolers.



METHODS

Hippocampal Subfield Volumes:

- Participants were scanned using a Siemens 3.0-T MRI (MAGNETOM Prisma System).
- T1-weighted structural scan were obtained, and hippocampal subfield volumes were segmented in Freesurfer 7.1.1⁹.
- The FS60 parcellation that includes CA1, CA3, CA4, DG, (CA2+CA3 and CA4+DG were combined) and molecular layer was used.

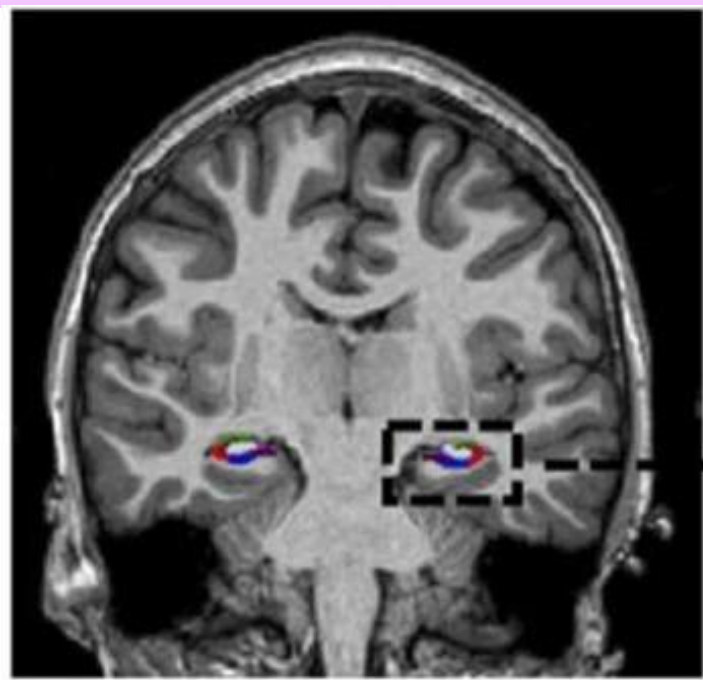


Figure 2. The Hippocampal segmentation in Freesurfer.

Table 1. Sample demographics (n=42)

Female [n (%)]	19 (45)
Age in months M (SD)	45.56 (8)
Child race, [n (%)]	
African American	5 (12)
Asian	2 (5)
Caucasian/White	17 (40)
Multi-Racial/Other	9 (21)
Not reported	1 (2)
Child ethnicity, [n (%)]	
Hispanic or Latino	9 (21)
Not Hispanic or Latino	33 (79)

Attention Difficulties:

- Parents filled out the Child Behavior Checklist (CBCL); we used the attention problems subscale for scoring.

Episodic Memory:

- Children completed the Mnemonic Similarity Task (MST) which tests children's ability to discriminate between similar stimuli.
- Target**=picture seen at encoding.
- Lure**=picture similar to Target, but not seen at encoding.
- Foil**=new picture not seen at encoding.
- Lure Discrimination Index (LDI) = Target Hits – Lure False Alarms
 - “Yes” Response to Targets – “Yes” Response to Lures
- Linear regression models were run controlling for age and ICV using R 4.4.1.¹⁰

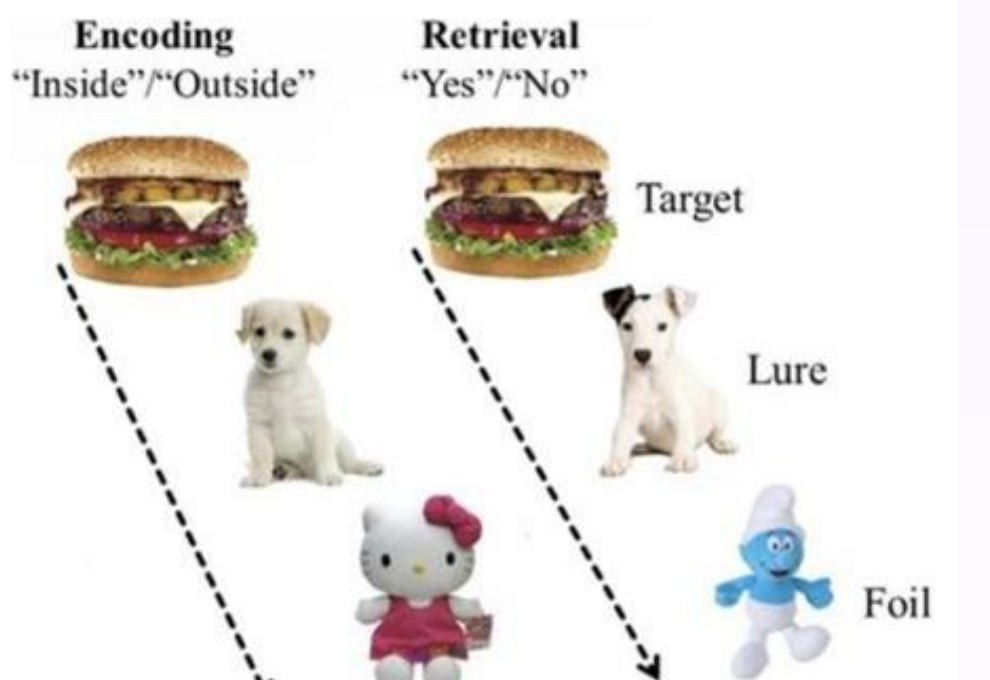


Figure 3. Task Design

RESULTS

	b	SE	t	p
CA1				
Attention	13.02	7.71	1.68	0.09†
MST	-0.73	1.05	-0.69	0.48
CA3				
Attention	10.48	2.9	3.61	<0.001**
MST	-0.79	0.42	-1.88	0.06†
CA4/DG				
Attention	11.46	5.62	2.03	0.04*
MST	-1.1	0.76	-1.44	0.15
Molecular Layer				
Attention	8.47	5.57	1.52	0.13
MST	-0.49	0.75	-0.65	0.51

Table 2. Results from LME models assessing the relation between hippocampal subfield volumes and attention, and hippocampal subfield volumes and MST controlling for age and ICV. † = p<0.1, * = p<0.05, ** = p<0.001

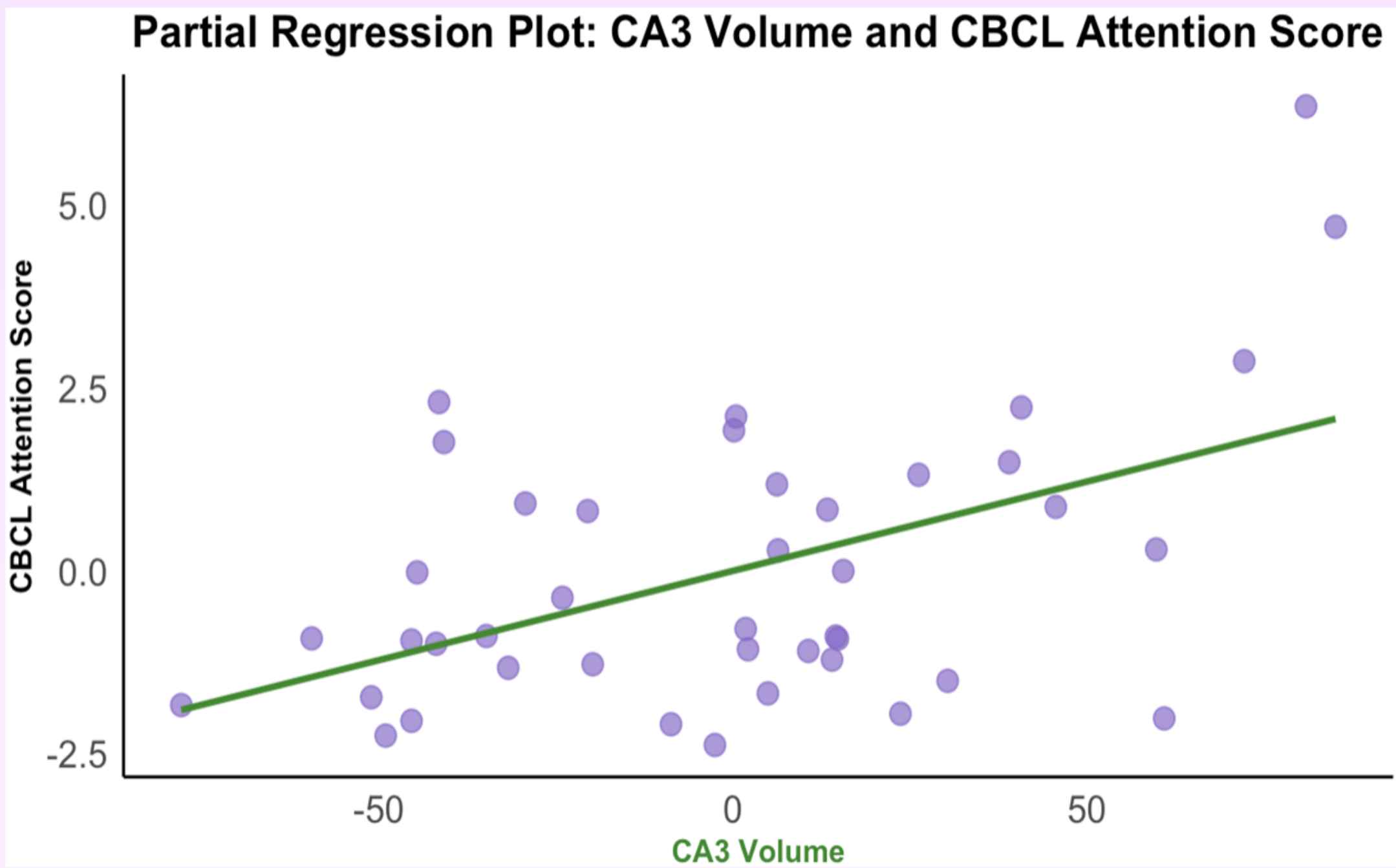


Table 3. Partial regression plot of LME model assessing the relation between CA3 volume and attention difficulties controlling for age and ICV.

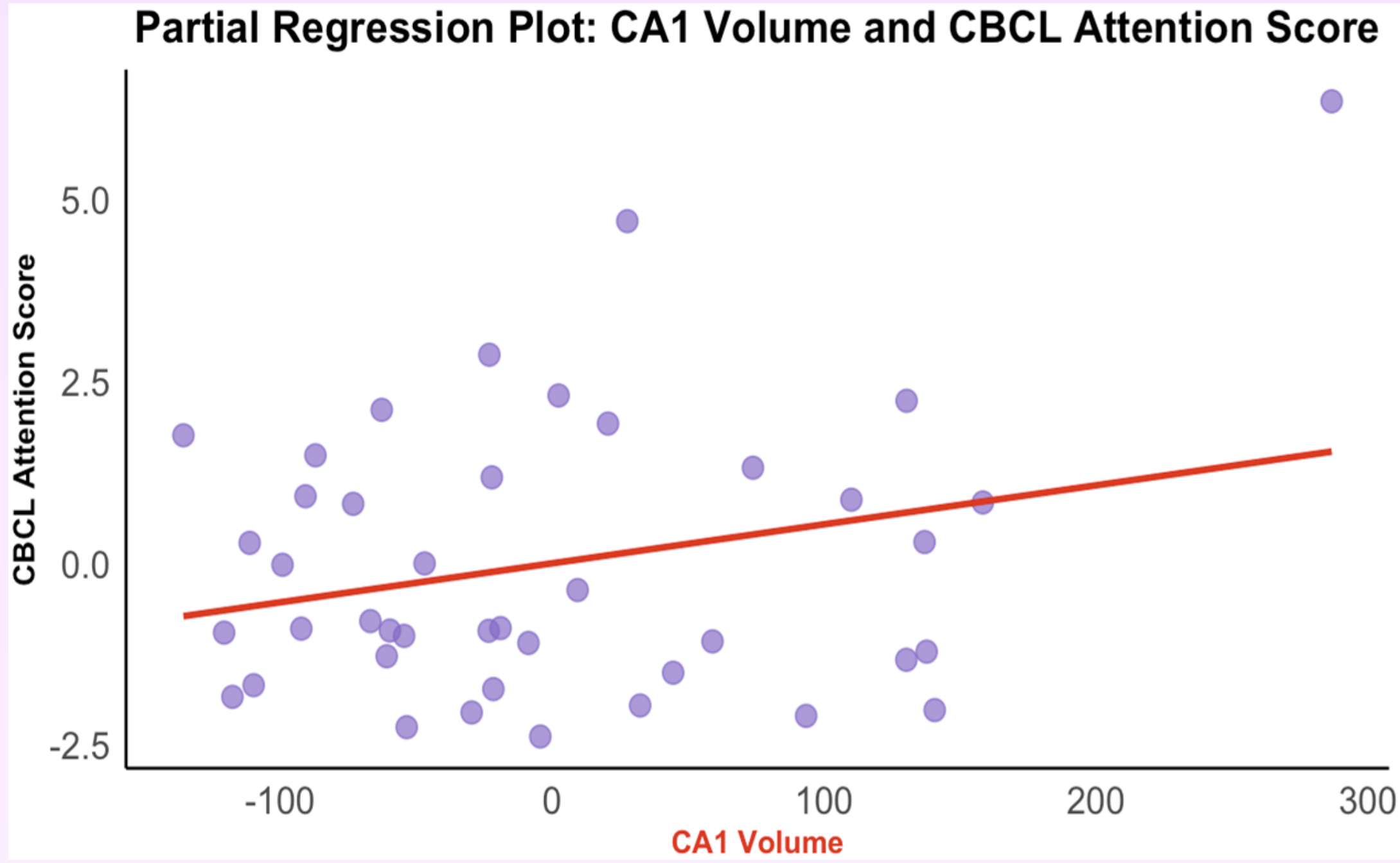


Table 4. Partial regression plot of LME model assessing the relation between CA1 volume and attention difficulties controlling for age and ICV.

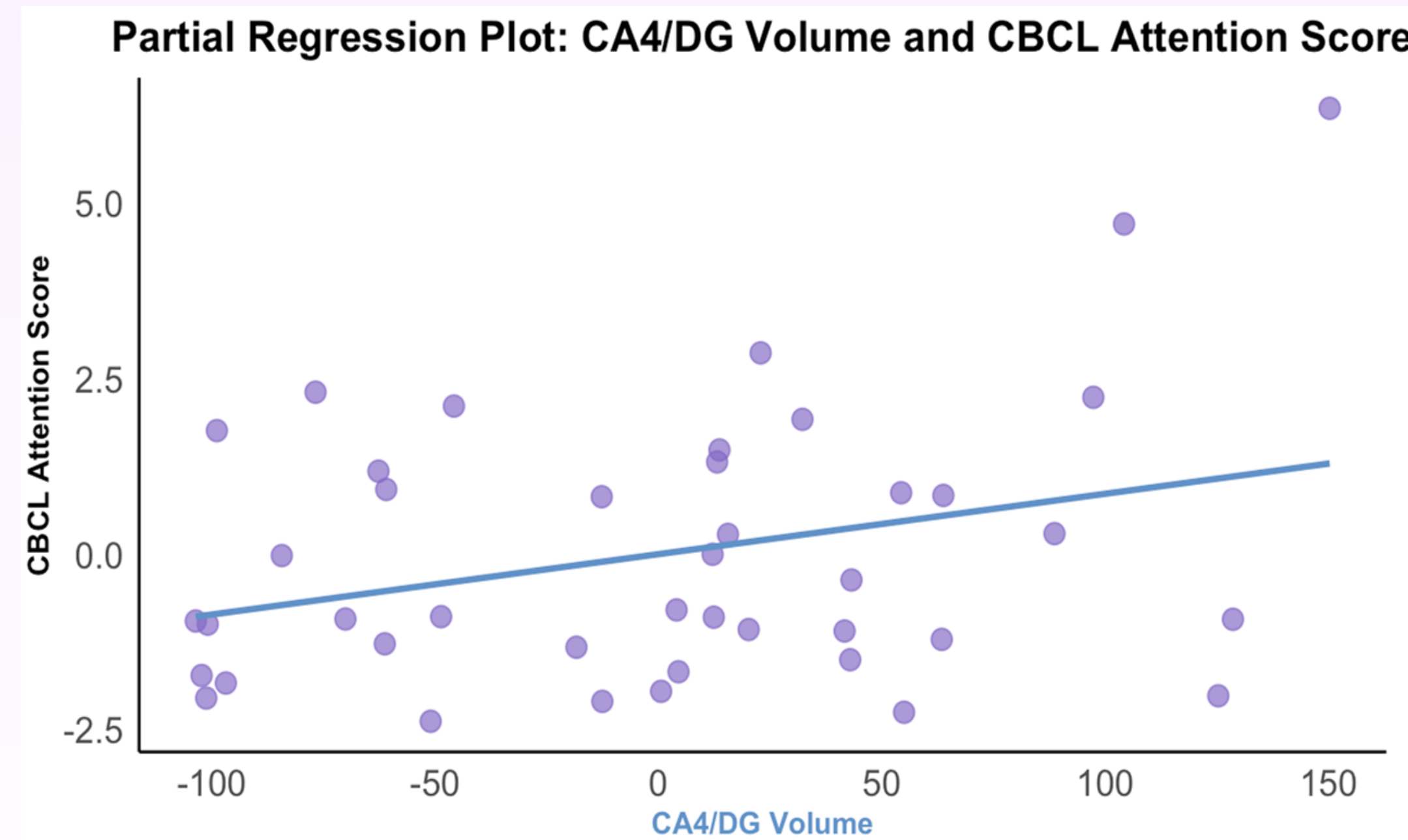


Table 5. Partial regression plot of LME model assessing the relation between CA4/DG volume and attention difficulties controlling for age and ICV.

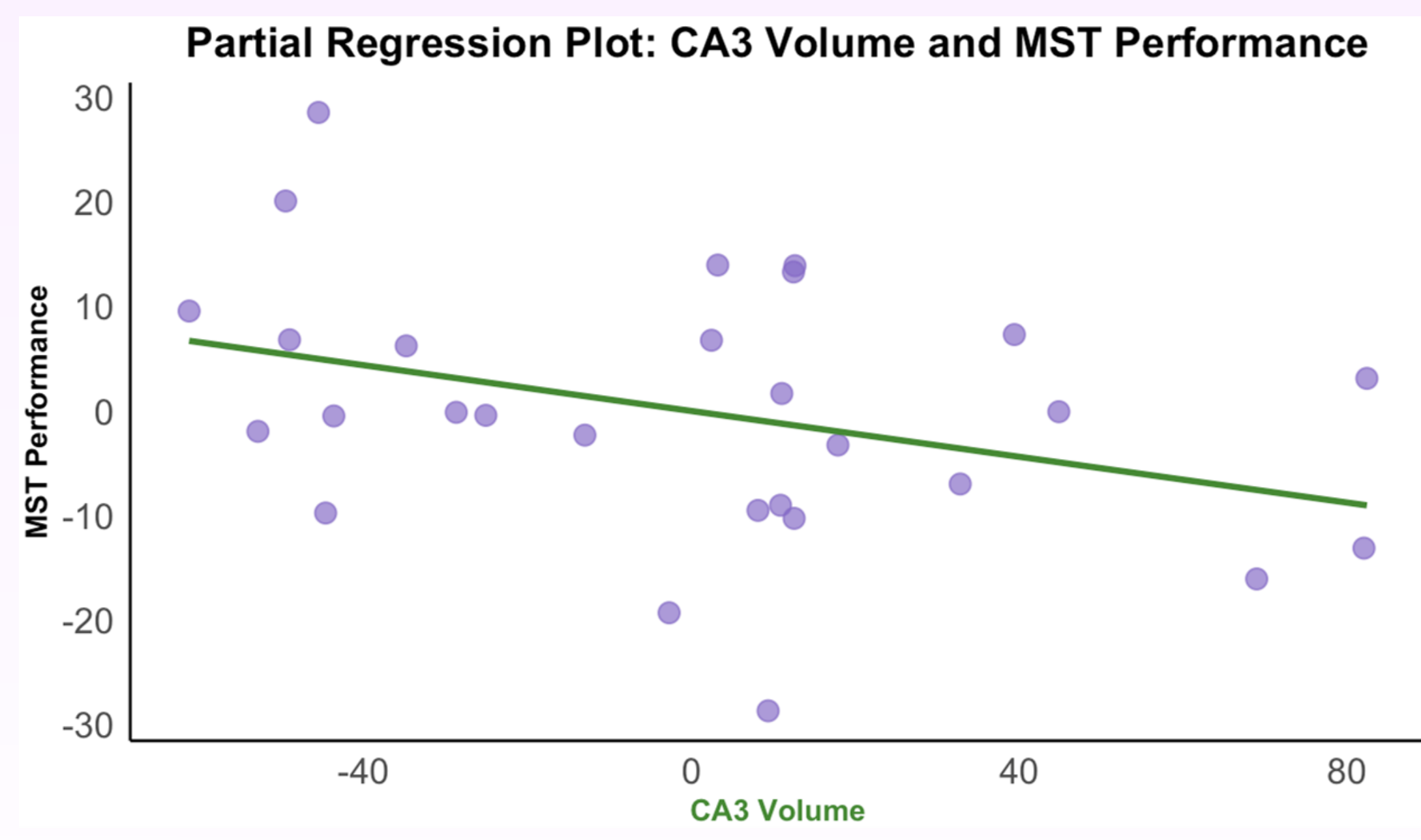


Table 6. Partial regression plot of LME model assessing the relation between CA3 volume and MST performance controlling for age and ICV.

Attention difficulties are associated with larger CA3 and CA4/DG hippocampal subfield volumes in preschoolers.

RESULTS

- Attention difficulties** were
 - Marginally and positively related to **CA1** subfield volume (p = 0.09).
 - Positively related to **CA3** volume (p < 0.001).
 - Positively related to **CA4/DG** volume (p = 0.04).
 - Not related to the molecular layer subfield volume.
- Memory performance** was:
 - Marginally and negatively related to **CA3** volume (p = 0.06).
 - Not related to **CA1**, **CA4/DG**, and molecular layer.
- There were no significant relations between

DISCUSSION

- This study is one of the few that have examined attention difficulties, episodic memory performance, and hippocampal subfield volumes in preschool-aged children.
- Attention difficulties are associated with greater **CA3** and **CA4/DG** volumes.
 - Aligns with previous research linking greater attention difficulties to larger hippocampal volumes in children with attention issues⁴, but, our sample was healthy (e.g., no diagnosed developmental disorder, ADHD, mental health conditions).
 - Distinct hippocampal subfields may play an important role in attention difficulties in preschoolers.
- Better memory performance (though marginal) is associated with smaller **CA3** volume.
 - Contrasts with studies linking larger hippocampal volume to better memory in young children.
- Findings challenge the “bigger is better” assumption.
 - Smaller volumes may be sufficient—or even advantageous—due to:
 - Synaptic pruning
 - Refined circuitry
 - Developmental timing of hippocampal maturation
- Future research should:
 - Explore children with ADHD to assess whether findings extend beyond healthy samples.
 - Investigate functional connectivity- does smaller hippocampus enhance other pathways for episodic memory, communication, and attention?
 - Use longitudinal models to track hippocampal changes over time and their role in memory development.

REFERENCES



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