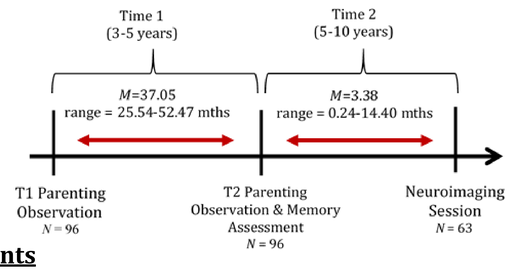
Positive, but not negative, parenting behavior in early childhood predicts both hippocampal volume and episodic memory ability in middle childhood

Morgan Botdorf, Sarah Blankenship, Lea Dougherty, & Tracy Riggins
University of Maryland, College Park

Introduction

- Early childhood experiences associated with parenting are critical for healthy development.
- Research has linked early maltreatment to differences in brain volume as well as a range of behavioral outcomes in children[1].
- However, more research is needed to elucidate the effect of typical variations in caregiving experiences on the developing brain and subsequent behavior[2].
- Research points to the hippocampus as being a main region impacted by the stress of early caregiving experiences[3].
- **The present study seeks to extend this research by investigating implications on behavioral outcomes. Specifically, we investigate a link between normal variations in parenting in early childhood, hippocampal volume, and subsequent episodic memory ability, a type of memory reliant on the hippocampus.**

Methods



Participants

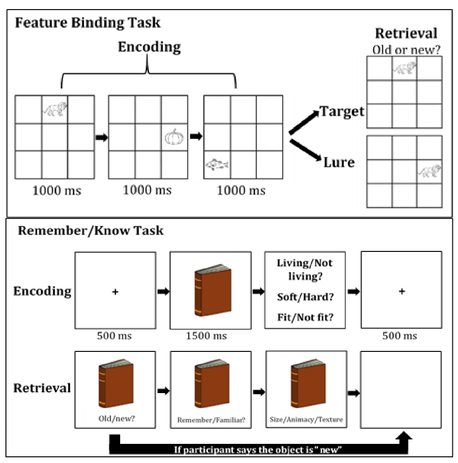
- 96 children (47 females) part of a longitudinal dataset overselected for a history of maternal depression.

Observational Parenting Assessments

- Children and their parents completed a series of tasks modified from the Teaching Tasks Battery[4].
- Each task was rated on Maternal Intrusiveness, Hostility, Support, Negative Affect, and Positive Affect. Measures were averaged and standardized to create two composite scores:
  - **Negative Parenting Composite**: Average of Maternal Intrusiveness, Maternal Hostility, and Maternal Negative Affect
  - **Positive Parenting Composite**: Average of Maternal Support and Maternal Positive Affect

Memory Assessment

- **Feature Binding Task**[5]:
  - Variable of interest: Percentage of trials with both item and location accuracy.
- **Source Memory Task**[6]**:**
  - Variable of interest: Out of accurate old trials, percentage of trials with a correctly identified source.
- Scores were standardized and averaged to create a Composite Memory Score.



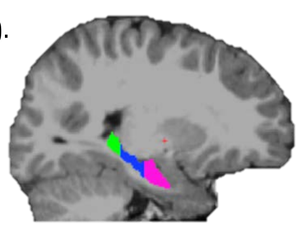
Methods: MRI Data

MRI Data Collection

- T1-weighted high resolution (1mm^3) anatomical images were acquired from a Siemens 3T scanner with a 32-channel coil at the Maryland Neuroimaging Center using a standard structural MRI scan sequence.

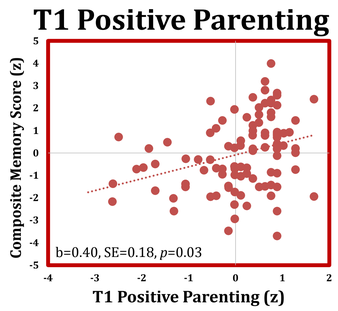
Hippocampal and Whole Brain Volume Extraction

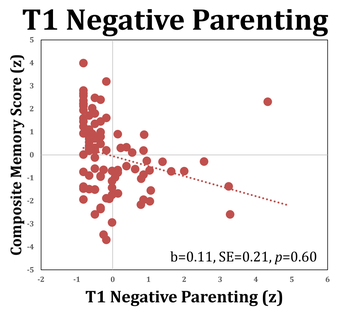
- Freesurfer v5.1[7] was used to derive Hippocampal and Intracranial Volumes (ICV).
- Automatic Segmentation Adapter Tool[8] was used to refine hippocampal volumes.
- Hippocampal subregions were manually identified using standard anatomical landmarks[9,10].
- Volumes were adjusted for total brain size[11].

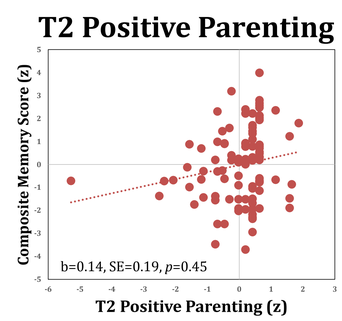


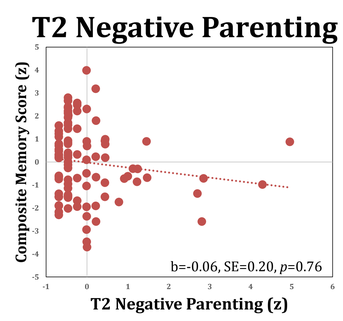
Results: Parenting-Memory Associations (*n*=96)

- T1/T2 Positive and Negative Parenting were entered as predictors in a multiple regression to test associations between parenting and composite memory scores.
  - Covariates: Age, gender, maternal depression, and IQ
  - T1 Positive Parenting was a significant predictor of memory performance, whereas the other parenting measures were not.



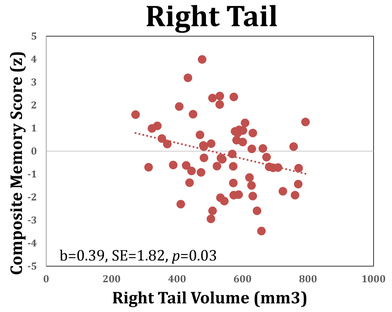






Results: Hippocampal Volume-Memory (*n* = 61)

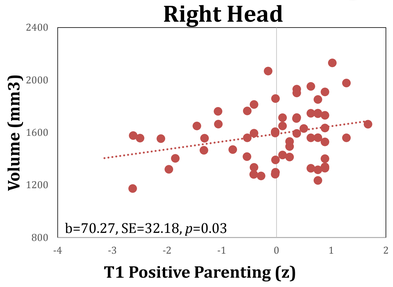
- Hippocampal subregion volumes (left/right head, body and tail) were entered as predictors in a multiple regression to test associations between subregion volume and Composite Memory Score.
  - Covariates: Age, gender, maternal depression, and IQ
  - Right tail volume was a significant predictor of memory performance, whereas the other subregions were not.



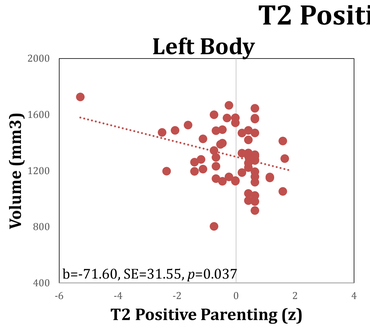
Results: Parenting-Hippocampal Volume (*n* = 62)

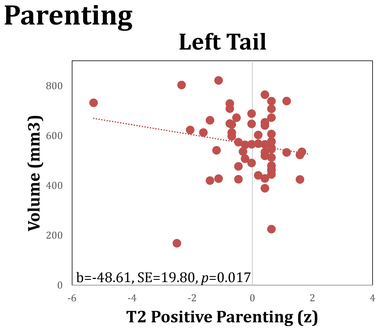
- T1/T2 Positive and Negative Parenting were entered as predictors in a multiple regressions to test associations between parenting and each hippocampal subregion volume.
  - Covariates: Age, gender, maternal depression, and IQ
  - T1 Positive Parenting was a significant predictor of right head volume.
  - T2 Positive Parenting was a significant predictor of left body volume and left tail volume.
  - T1/T2 Negative Parenting were not significant predictors of any of the subregion volumes.

T1 Positive Parenting



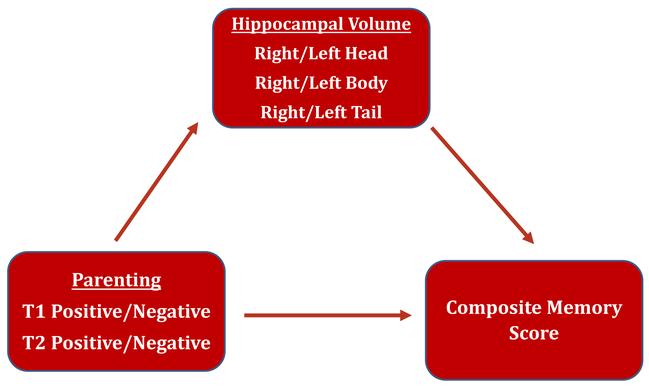
T2 Positive Parenting





Results: Mediation

- A mediation model was tested using Hayes' SPSS Process macro (Hayes, 2013). Separate models were run with T1/T2 Positive or Negative Parenting as the predictor, right/left hippocampal head, body, or tail as the mediator, and Composite Memory Score as the dependent variable. Significant mediation was not observed for any of the models.



Discussion

- These results provide support for the influence of parenting, within the typical range, on cognitive abilities, specifically episodic memory ability, and the development of the hippocampus.
  - Greater T1 Positive Parenting is associated with increased bilateral hippocampal head volume and episodic memory ability.
  - Greater T2 Positive Parenting is associated with decreased left hippocampal body and tail volume. Although results did not reach significance, T2 Positive Parenting shows a positive association with episodic memory ability.
  - T1/T2 Negative Parenting exhibits a negative association with episodic memory, although not significant.
- These results suggest that the timing of parenting is important for both subsequent brain development and behavioral outcomes.
  - Results suggest that early parenting may impact memory more than later, concurrent parenting
  - Additionally, early and concurrent positive parenting may differentially impact different subregions of the hippocampus.
  - Exact timing and specificity of the impact of parenting on memory and the hippocampus should be investigated further.
- Although our research did not support a mediation model linking parenting, hippocampal volume, and episodic memory ability, future research should continue to investigate the mechanism through which early experiences of parenting affect memory.
- Once this link has been elucidated, research can focus on deriving interventions to target children who may be at an increased risk of memory impairments.

Acknowledgements

We would like to thank the families for participating in this study and members of CSEL, NCDL, and the MNC for assistance with subject recruitment and testing. This research was supported by the University of Maryland (UMD) College of Behavioral and Social Sciences Dean's Research Initiative Award, the UMD Research and Scholars Award, and the National Science Foundation (NSF) in partnership with the University of Maryland ADVANCE Program for Inclusive Excellence Award.

References

1. Nelson C.A., Bos K., Gunnar M.R., & Sonuga-Barke E.J.S. (2011). V. The neurobiological toll of early human deprivation. *Monographs Of The Society For Research In Child Development*, *76*(4), 127-146.
2. Belsky, J., & de Haan, M. (2011). Annual Research Review: Parenting and children's brain development: the end of the beginning. *Journal Of Child Psychology And Psychiatry*, *52*(4), 409-428.
3. Luby, B., Barch, D., Belden, A., Gaffrey, M., . . . Botteron, K.. (2012). Maternal support in early childhood predicts larger hippocampal volumes at school age. *Proceedings of the National Academy of Sciences of the United States of America*, 109(8), 2854-9.
4. Egeland et al., (1995). Teaching tasks administration and scoring manual.
5. Lorsbach, T., & Reimer, J. (2005). Feature binding in children and young adults. *Journal of Genetic Psychology*, 166(3), 313-327.
6. Ghetti, S., & Lee, J. (2011). Children's episodic memory. *Wiley Interdisciplinary Reviews: Cognitive Science*, 2(4), 365-373.
7. Fischl, B. (2012). FreeSurfer. NeuroImage, 62, 774–781. doi:10.1016/j.neuroimage.2012.01.021
8. Wang H, Das SR, Suh JW, Altinay M, Pluta J, Craige C, Yushkevich PA (2011): A learning-based wrapper method to correct systematic errors in automatic image segmentation: Consistently improved performance in hippocampus, cortex and brain segmentation. *NeuroImage*, 55:968–985.
9. DeMaster, D. M., & Ghetti, S. (2012). Developmental differences in hippocampal and cortical contributions to episodic retrieval. *Cortex; a journal devoted to the study of the nervous system and behavior*.
10. Riggins, T., Blankenship, S. L., Mulligan, E., Rice, K., & Redcay, E. (2015). Developmental differences in relations between episodic memory and hippocampal subregion volume during early childhood. *Child Development*, 86(6), 1710-1718.
11. Raz, N., Lindenberger, U., Rodrigue, K. M., Kennedy, K. M., Head, D., Williamson, A., . . . Acker, J. D. (2005). Regional brain changes in aging healthy adults: General trends, individual differences and modifiers. *Cerebral Cortex, 15*, 1676–1689.

For questions or comments, please contact
mbotdorf@terpmail.umd.edu