Developmental and Environmental Influences on Adolescent Hippocampal Myelination

Martinez, A.[1], Sydnor, V.J.[1], Verma, P.K.[1], Foran, W.[1], Parr, A.C. [1], Calabro, F.J.[1,2] Luna, B.[1,2,3]

Departments of [1]Psychiatry, [2]Bioengineering, [3]Psychology, University of Pittsburgh, Pittsburgh, PA

Background

- The hippocampus (HPC) is a highly plastic brain region critical for environmental adaptation. Prior work has demonstrated structural maturation of the HPC through adolescence, with developmental trajectories altered in the presence of environmental deprivation.[2,5]
- Myelination has been proposed as a potential mechanism for structural maturation and adaptation, with animal studies indicating prolonged HPC myelination through development, and responsiveness to environmental impact. However, limited work has examined how HPC myelination unfolds throughout human adolescence and how environmental factors shape this trajectory.[4]
- Distress Tolerance, how individuals respond to negative emotions – including perceived ability to tolerate, accept, manage, and function through upset feelings or stress, may reflect environmental impact on neurodevelopment. Distress tolerance may be shaped by early life environment, yet its role in adaptability and relationship to HPC development remain relatively unexplored.[1,3]

To bridge these gaps, this study aimed to:

- Examine how HPC myelination unfolds across youth from adolescence into young adulthood.
- Examine how neighborhood deprivation is associated with markers of HPC myelination.
- Examine how levels of Distress Tolerance – a marker of adaptive coping – may buffer against deprivation effects on HPC myelination.

Hypothesis: We hypothesize that HPC myelination will increase with age, consistent with prior structural developmental findings, but will be blunted by deprivation. We additionally predict that greater distress tolerance will act as a buffering factor against these effects.

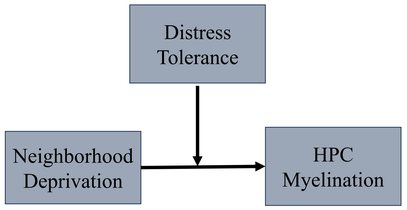


Fig.1 Conceptual Model

Methods

Participants

150 participants (baseline ages 10-32; 50% Female) were scanned up to 3 times at 18-month intervals (total 226 visits).

Hippocampal Myelination

- Ultra-high field quantitative (7T) MRI scans performed on a Siemens Magnetom. MP2RAGE-derived R1 was extracted from HPC.

Neighborhood Deprivation Index

- Deprivation was indexed using the ***Area Deprivation Index*** with higher scores reflecting greater deprivation.

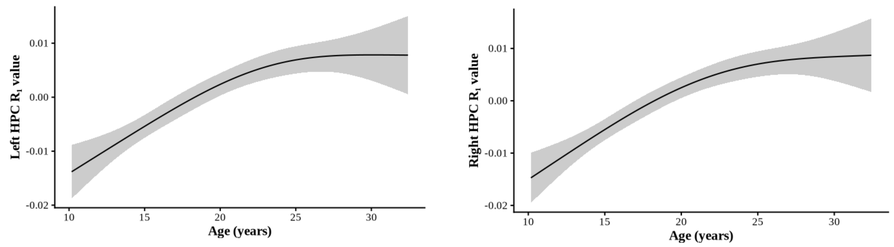
Distress Tolerance

- Distress tolerance was assessed using a 15-item self-report ***Distress Tolerance Scale*** (DTS; Simmons, 2015) and was categorized into four subscales: Tolerance, Absorption, Appraisal, and Regulation. Higher scores reflect greater inability to tolerate forms of distress.

Statistical Analysis

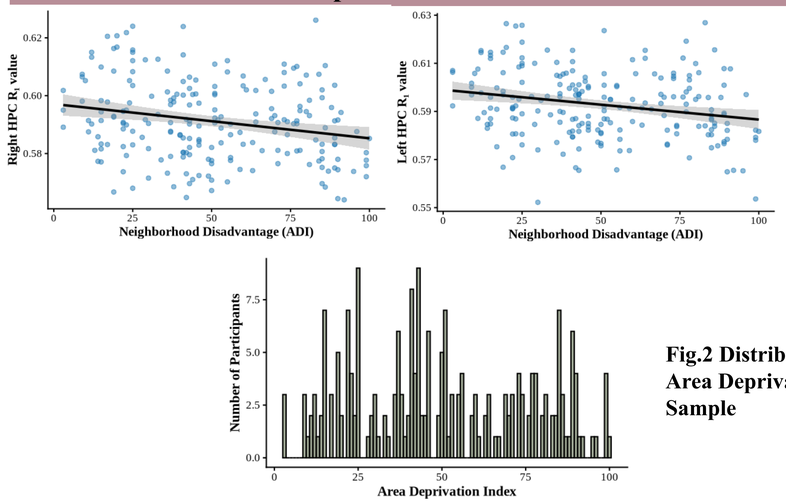
- Generalized additive mixed models (GAMMs) tested nonlinear age effects and associations between all variables of interest.

Nonlinear age-related increases in R1 across the HPC



R1 showed significant nonlinear age increases in both HPC hemispheres (Right: F = 22.17, p < 0.0001; Left: F = 25.8, p < 0.0001).

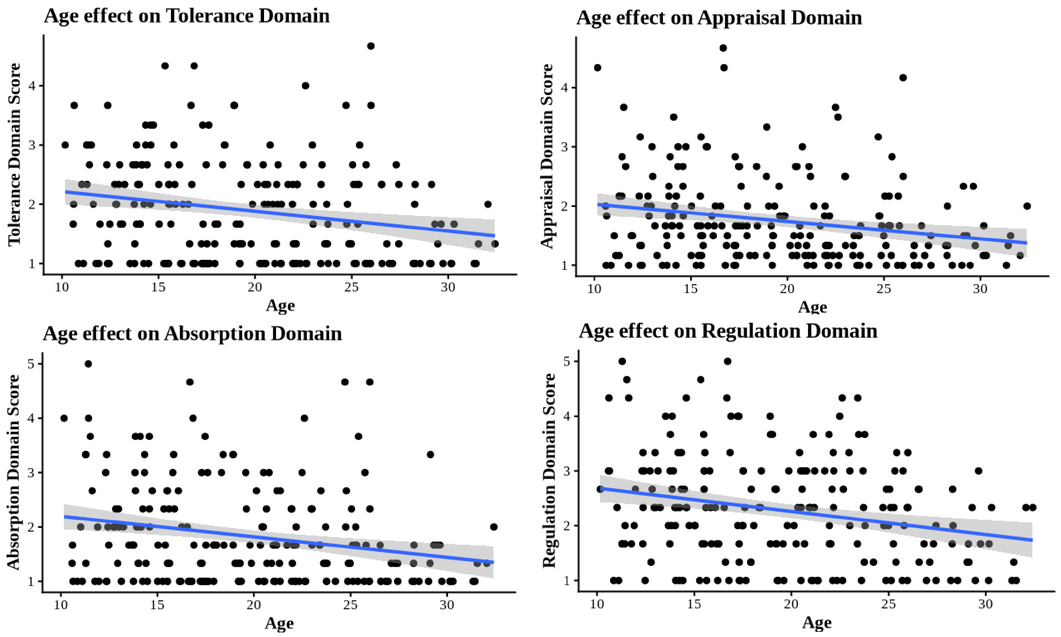
Greater Deprivation is associated with lower HPC-R1



Controlling for age, greater deprivation was related to lower HPC R1 (Left: t = -2.718, p = 0.007; Right: t = -2.713, p = 0.007).

Fig.2 Distribution of Area Deprivation Across Sample

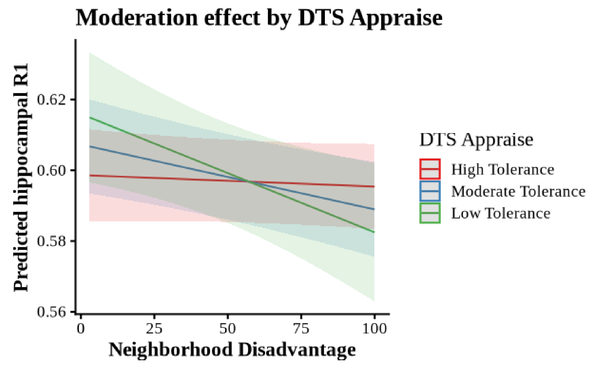
Distress Tolerance Increases with Age



DTS scores improved with age in all subdomains (p's < .001).

Moderating effect of Distress Tolerance Appraisal

A trend-level moderation effect (t = -1.881, p = .06) indicated that the impact of neighborhood disadvantage (ADI) varied with distress tolerance. Specifically, individuals with low tolerance exhibited the strongest impacts of neighborhood disadvantage on hippocampal R1, while those with high tolerance may be protected against this effect.



Conclusions

- We show that R1 increased non-linearly in both HPC hemispheres, reflecting developmental increases in myelination through adolescence.
- Neighborhood deprivation was linked to lower HPC myelination suggesting myelination may be affected by contextual adversity.
- Distress tolerance, specifically appraisal processes, was suggestive of protective properties, though further work is needed to characterize this association.
- Future work will examine whether neighborhood deprivation impacts maturational trajectories in HPC myelination, and whether distress tolerance may buffer against these effects in a developmentally-specific manner, which can inform the timing of interventions.
- Overall, this work is informative to the critical need to address global and domestic polices in effort to reduce social inequities, and may provide insight into neighborhood-based and individualized interventions to bolster coping mechanisms in at-risk youth.

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References & Author Information

Angela Maritnez, B.S.
Email: ***martineza10@upmc.edu***

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