Residential Greenspace is Associated with Psychological and Neural Signatures in Trauma-Exposed Adults

Kate Webb[1,2], Tim Ely[3], Lauren Lebois[1,2], Sanne van Rooij[3], Steven Bruce[4], Vishnu Murty[5], Tanja Jovanovic[6], Stacey House[7], Samuel McLean[8], Jennifer Stevens[3], Kerry Ressler[1,2], & Nathaniel Harnett[1,2]

1. Division of Depression and Anxiety, McLean Hospital, Belmont, MA; 2. Department of Psychiatry, Harvard Medical School, Boston, MA; 3. Department of Psychiatry and Behavioral Science, Emory University, Atlanta, GA. 4. Department of Psychological Sciences, University of Missouri - St. Louis, St. Louis, MO; 5. Department of Psychological and Neuroscience, Temple University, Philadelphia, PA; 6. Department of Psychiatry and Behavioral Neurosciences, Wayne State University, Detroit, MI; 7. Department of Emergency Medicine, Washington University School of Medicine, St. Louis, MO; 8. Institute for Trauma Recovery, Department of Anesthesiology and Emergency Medicine, University of North Carolina, Chapel Hill, NC.

Background

- Neighborhood characteristics can impact post-trauma trajectories.[1]
- Risk factors are associated with neural vulnerabilities to PTSD.[2] However, less is known about how resilience factors impact neurobiology.
- Greenspaces are associated with better mental and physical health and lower mortality rates. [3]

Current Study

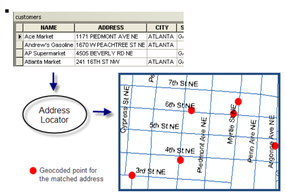
1. Does greenspace predict PTSD symptom trajectories?

2. Does internal resilience (CD-RISC scores) moderate how well external resilience (greenspace) buffers against symptomatic trajectories?

3. Does greenspace impact neural reactivity to reward?

Geocoding Methods

1.

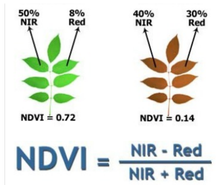


X Y coordinates of participants' home addresses were derived

2.

High-resolution (30m) multiband satellite imagery from the Landsat 8 archive was extracted from Google Earth Engine (GEE).

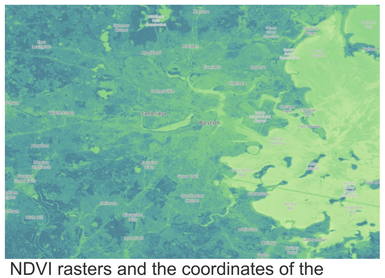
3.



Computation of the normalized difference vegetation index (NDVI) was performed in GEE

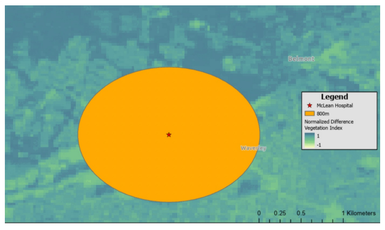
Scan for full NDVI methods and code!

4.



NDVI rasters and the coordinates of the participants' home addresses were entered into ArcGIS Pro

5.



Euclidean buffers were created around each address with increasing radiuses

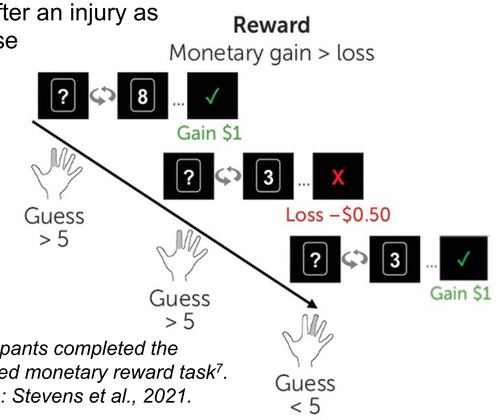
Acknowledgments

- NIMH U01MH110925, K00MH119603 (Harnett); T32 through Harvard School of Public Health (Webb)
- Thanks Carissa Tomas and Harvard Center for Geographical Analysis for guidance.

AURORA
Scientific discovery to provide new hope for veterans and trauma survivors
NIH National Institute of Mental Health
The MAYDAY Fund
ONE MIND
verily
AURORA is made possible with grateful support from NIMH, One Mind, Mayday, and Google/Verily Life Sciences

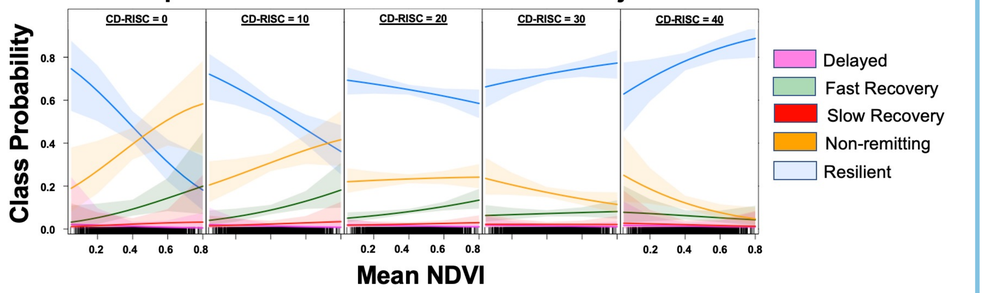
Study Design

- Trauma survivors were recruited ~72 hours after an injury as part of a longitudinal, multisite study of adverse posttraumatic neuropsychiatric sequalae.[4]
- PTSD symptoms (PCL-5 scores) were evaluated at 2-weeks, 8-weeks, 3-months, 6-months post-injury.
- Connor-Davidson Resilience Scale (CD-RISC) evaluated internal resilience.
- Neuroimaging data was collected 2-weeks post-injury.
- fMRI data was analyzed in fMRIprep.[5-6]
- ROIs were selected *a priori* and the mean of voxels across regions of interest (ROIs) were extracted).



Participants completed the modified monetary reward task[7]. Figure: Stevens et al., 2021.

Greenspace x Internal Resilience on PTSD Trajectories



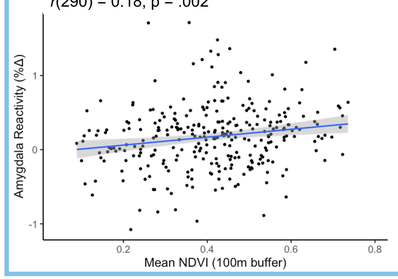
Participants with higher NDVI *and* higher internal resilience (CD-RISC) were significantly more likely to fall in the resilient trajectory ($ps_{corrected}$<.05). However, individuals with low internal resilience and high greenspace were no more likely to fall in resilient trajectory compared to the non-remitting trajectory.

Main Findings

- Greenspace was associated with a greater likelihood of falling in a recovery trajectory.
- Internal resilience was associated with greater likelihood of falling in resilient trajectory.
- At **lower** levels of CDRISC, there is no benefit of NDVI. However, at **higher** levels of CDRISC, higher NDVI is associated with an even higher likelihood of falling in resilient trajectories.
- Greenspace was associated with greater amygdala reactivity to reward.

Greenspace and Reward Reactivity

$r(290) = 0.18$, p = .002

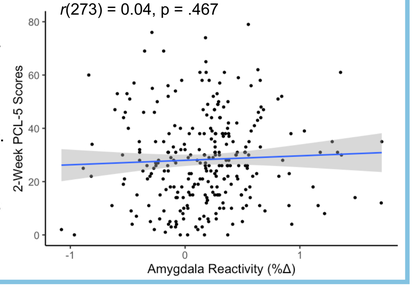


Greenspace is associated with amygdala reactivity to reward (p < .001) after covarying for income, sex at birth, neighborhood disadvantage, and age.

However, amygdala reactivity to reward was not predictive of PTSD symptoms over time.

Reward Reactivity and PTSD

$r(273) = 0.04$, p = .467



References

1. Tomas et al., 2022; **2.** Admon et al., 2013; **3.** Berman et al., 2019; **4.** McLean et al., 2020; **5.** Stevens et al., 2023; **6.** Harnett et al., 2021; **7.** Proust-Lima et al., 2015.

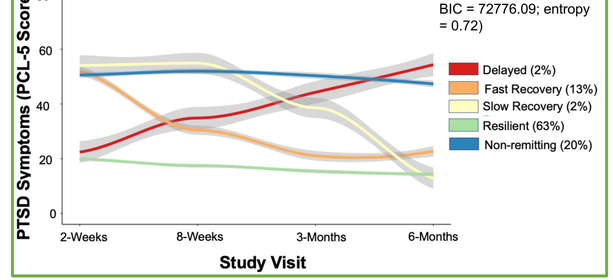
Trajectory Methods

- Latent Class Growth Curve Modeling was conducted with R package *'lcmm'*[7]
- Participants must have 4/5 timepoints
- 3-step approach:

1. Identify the number of trajectories (1-7)
   - Linear and quadratic slopes were compared.
   - Considered log-likelihood, AIC, BIC, entropy, as well as theoretical interpretability.
2. Extract class membership for each participant
3. Predict class using logistic regression (*'multinom'*package)
   - Examine greenspace, CDRISC, and interaction term
   - Adjust for income, sex at birth, age, neighborhood socioeconomic disadvantage, trauma type, marital status and childhood trauma questionnaire.

Results

- N = 2,223; 63% women, M age = 36 years old, SD = 13; majority (74%) motor vehicle crash; 50% non-Hispanic Black; 35% non-Hispanic White.



Conclusions

- Greenspace works in conjunction with individual factors to protect against posttraumatic dysfunction and modulates neural responses to reward.
- The effectiveness of greenspace depends on an individual's internal resilience.

Strengths

- Geographical variability
- NDVI derived pre-trauma

Limitations

- Residential stability
- MRI sample is significantly different from the full sample (5 out of 22 study sites completed neuroimaging)
- Evaluating environmental factors which promote psychological recovery has important implications for clinical care and public policy.

Get in Touch!

ekwebb@mclean.harvard.edu
@_brainstorm_12