Characterizing relationships between working memory and the environment in childhood

Wesley J. Meredith*, Carlos Cardenas-Iniguez*, Marc G. Berman, Monica D. Rosenberg
Department of Psychology, University of Chicago; *Authors contributed equally

Background

Working memory allows us to store and manipulate information in mind [1]

Social and cultural environments relate to executive functions including working memory [2-7]

Working memory capacity impacts important outcomes in development, including reading and math achievement [8-11]

Can we identify latent variables that characterize different aspects of a child's environment?

How do these environmental factors relate to working memory function?

ABCD study

Data: Adolescent Brain Cognitive Development study release 2.0.1 [12, 13]

Environment variables based on: 1) parent- and child-report data and 2) publicly available national data at the census tract level

Participants: 10,288 9–10-year-olds from 21 sites across the United States (48% F)

Exclusion criteria: Participants with missing environmental data were excluded from analysis

Participants with missing sex (.1%), race and ethnicity (.2%), household income (9%), and parent education (.3%) data had values imputed using the mice package in R [14]

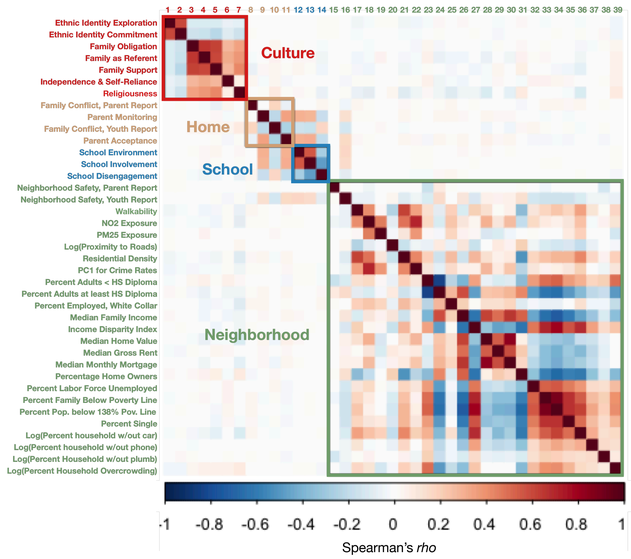
Computational resources

PCA: Principal components analysis was conducted on each set of environment variables (home, school, neighborhood, cultural) separately using the FactoMineR package in R [15]

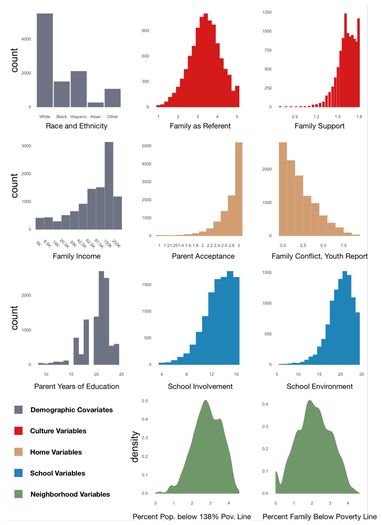
Research Computing Center: Data were stored and processed using RCC resources including Midway2 and the Secure Data Enclave. Future neuroimaging analyses will implement RCC High Performance Computing resources

Identifying home, school, neighborhood, and cultural environmental factors

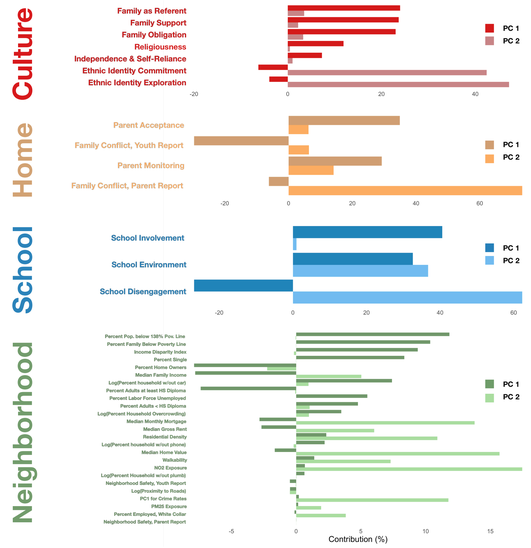
Correlations between environmental variables



Covariate and exemplar distributions

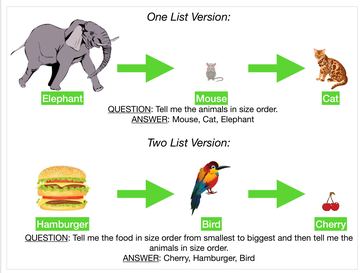


Variable contributions to PC1 and PC2



Relating environmental factors to working memory

Working memory list sorting task



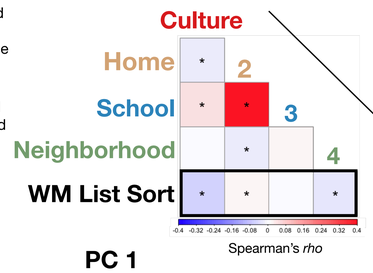
Tulsky et al. (2014).

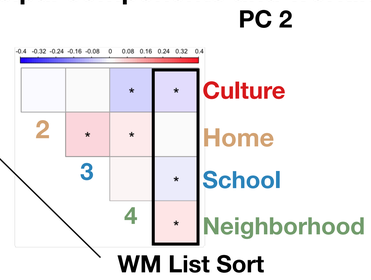
Correlations between environmental principal components and working memory

lower cultural familial ties and less connection to ethnic identity associated with worse working memory

More parent acceptance and less family conflict associated with better working memory

more neighborhood poverty associated with worse working memory





weaker ethnic identity associated with worse working memory

increased school disengagement associated with worse working memory

aspects of urbanicity and neighborhood affluence associated with better working memory

Conclusions

The first two principal components for each factor explained more than 40% of the observed variance in environmental measures

Relationships between working memory and the first and second environmental principal components are modest but statistically significant

Future work will investigate how relationships between working memory and environmental factors are mediated by functional neural phenotypes and change across adolescence

References

[1] Baddeley. (1992). *Science*
[2] Dadvand et al. (2015). PNAS
[3] Ready et al. (2019). Early Child Res Q
[4] Rhoades et al. (2011). J Exp Child Psychol
[5] Rivas et al. (2019). Environ Health Persp
[6] Sarsour et al. (2011). J Int Neuropsych Soc
[7] Sunyer et al. (2015). PLOS Med
[8] Alloway et al. (2010). J Exp Child Psychol
[9] Bayliss et al. (2003). J Exp Psychol Gen
[10] De Smedt et al. (2009). J Exp Child Psychol
[11] Nauwers et al. (2017). Read Writ
[12] Casey et al. (2018). *Dev. Cogn. Neurosci.*
[13] Hagler et al. (2019). *NeuroImage*
[14] van Buuren & Groothuis-Oudshoorn. (2011). *J Stat Softwar*
[14] Le et al. (2008). *J Stat Softwar*

Behavioral, demographic, and quality control data used in these analyses came from NIMH Data Archive Digital Object Identifier (DOI) 10.15154/1504041. DOIs can be found at nda.nih.gov/study.html?id=721.