The poor do poorer: how coming from a low-income home impacts brain and language development

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Background

- A childhood in poverty negatively impacts brain and cognitive development[1-4]
- These differences result in life-long academic and economic implications.
- Resting state EEG provides insights into how a childhood in poverty may influence brain development.[5-6]
- Little work has addressed the relationship between poverty, resting state EEG and cognitive/language outcomes for children raised in the US.

Purpose

(1) Investigate how coming from a low-income home in the US impacts resting state EEG and (2) Clarify the relationship between SES related differences in resting state EEG and vocabulary, working memory & phonological memory.

Methods

Participants.
- 45 children from low-income homes
- 45 age- and gender-matched children from higher-income homes

Demographics
- Participants were all between the ages of 8-15 years (M=10.9, SD=2.14) and were 60% female.

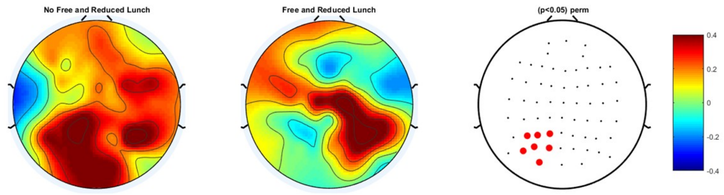
Income Status
- Income status was determined by eligibility for free and reduced lunch.
- Maternal education at 3 levels:
  - High School Degree or lower(36.7%)
  - Partial College (25.6%)
  - College or Graduate Degree (37.8%)

EEG Equipment.
•Neuroscan EEG System, 62 electrode cap

Methods.
- Peabody Picture Vocabulary Task 4th Edition (PPVT-4)[7]
- Digit Span[8]
- Non-Word Repetition Task[9]
- Parents completed the Confusion, Hubbub and Order Scale (CHAOS)[10] to measure the degree of confusion and disorganization in the child's home environment.

Results: Resting State EEG & Multiple Regression

Alpha (9-12 Hz)



Outcome: Vocabulary

Variables	*B*	*SE B*	*ß.*
Age	.61	.97	.06
Language History	-6.37	4.85	-.15
Maternal Education	7.82	2.81	.33**
CHAOS	-.001	.003	-.04
Alpha Amplitude	3.97	2.05	.19
Theta Amplitude	2.05	2.83	.07
Beta Amplitude	-4.87	3.44	-.14
Alpha x Income Interaction	4.43	2.03	.21*
Theta x Income Interaction	-3.97	2.85	-.13
Beta x Income Interaction	.90	3.59	.03
R^2		.34	
F for change in R^2		3.94***	

Note: Income was centered at its mean
*p< .05. **p< .01. ***p< .001.

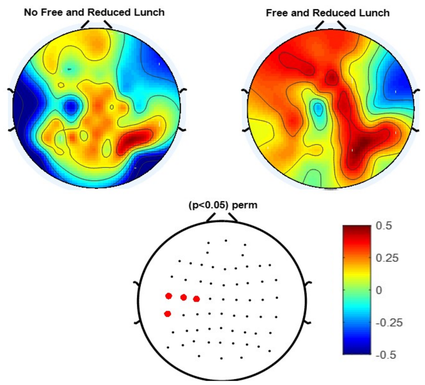
Outcome: Working Memory

Variables	*B*	*SE B*	*ß.*
Age	.44	.12	.42***
Language History	.11	.63	.02
Maternal Education	.29	.37	.11
CHAOS	.00	.00	-.12
Alpha Amplitude	.16	.27	.07
Theta Amplitude	-.93	.42	-.27*
Beta Amplitude	-.08	.47	-.02
Alpha x Income Interaction	.02	.27	.01
Theta x Income Interaction	.65	.43	.19
Beta x Income Interaction	-.32	.49	-.08
R^2		.31	
F for change in R^2		2.59*	

Note: Income was centered at its mean
*p< .05. **p< .01. ***p< .001.

Theta (4-8 Hz)

Beta (13-18 Hz)



Outcome: Phonological Memory

	Model 1			Model 2		
Variables	*B*	*SE B*	*ß.*	*B*	*SE B*	*ß.*
Age	.64	.41	.17	.20	.39	.05
Language History	-2.69	2.06	-.16	-1.50	1.86	-.09
Maternal Education	1.83	1.23	.19	.17	1.17	.02
CHAOS	-.004	.001	-.31**	-.003	.001	-.26**
Alpha Amplitude	1.06	.89	.13	.44	.79	.05
Theta Amplitude	-1.74	1.38	-.14	-1.24	1.28	-.10
Beta Amplitude	.81	1.56	.06	2.24	1.44	.16
Alpha x Income Interaction	2.31	.89	.28**	1.51	.83	.18
Theta x Income Interaction	.91	1.41	.07	.72	1.28	.06
Beta x Income Interaction	-4.58	1.60	-.32**	-4.95	1.43	-.34***
Digit Span				1.01	.39	.28**
PPVT 4				.16	.06	.37**
R^2		.44			.59	
F for change in R^2		4.57***			6.67***	

Note: Income was centered at its mean
*p< .05. **p< .01. ***p< .001.

Conclusions

- There were significant differences in resting state EEG based on income status
- These resting state differences predicted differences in vocabulary, working memory, and phonological memory

Vocabulary
- For children from low-income homes, increases in alpha predicted larger vocabulary size.

Working Memory
- Increases in theta predicted working memory performance for both low and high-income children

Phonological Memory
- Decreases in beta power predicted improved phonological memory in low-income children.

Take Home Message

This is the first study to show the relationship between resting state EEG and cognitive/language outcomes between low and higher income children. Specifically we found that:

1. Children from low income homes exhibit less alpha, less beta and more theta in resting state EEG than those from high income homes.

2. These differences in resting state EEG correspond to differences in vocabulary, working memory and phonological memory

3. Each of these relationships between parent income, brain activity and cognition held even when controlling for maternal education, indicating the effect of income is unique from the effect of parent education.

References

1. Noble, K. G., Houston, S. M., Kan, E., & Sowell, E. R. (2012). Neural correlates of socioeconomic status in the developing human brain. Developmental Science, 15(4), 516-527.
2. Ursache, A., & Noble, K. G. (2016). Socioeconomic status, white matter, and executive function in children. Brain and Behavior, 6(10)
3. Ursache, A., Noble, K. G., & Blair, C. (2015). Socioeconomic status, subjective social status, and perceived stress: Associations with stress physiology and executive functioning. Behavioral Medicine, 41(3), 145-154.
4. Perkins, S. C., Finegood, E. D., & Swain, J. E. (2013). Poverty and language development: Roles of parenting and stress. Innovations in Clinical Neuroscience, 10(4), 10-19.
5. Harmony, T., Alvarez, A., Pascual, R., Ramos, A., Marosi, E., Díaz De León, A. E., ... & Becker, J. (1988). EEG maturation on children with different economic and psychosocial characteristics. International Journal of Neuroscience, 41(1-2), 103-113.
6. Perone, S., Almy, B., & Zelazo, P. D. (2018). Toward an understanding of the neural basis of executive function development. In The neurobiology of brain and behavioral development (pp. 291-314).
7. Dunn, Lloyd M.Dunn, Douglas M. (2007) PPVT-4 :Peabody picture vocabulary test Minneapolis, MN. : Pearson Assessments,
8. Blackburn, H. L., & Benton, A. L. (1957). Revised administration and scoring of the digit span test. Journal of consulting psychology, 21(2), 139.
9. Dollaghan, C., & Campbell, T. F. (1998). Nonword repetition and child language impairment. Journal of Speech, Language, and Hearing Research, 41(5), 1136-1146.
10. Matheny Jr., A.P., Wachs, T.S., Ludwig, J.L. & Phillips, K. (1995). Bringing order out of chaos: Psychometric characteristics of the confusion, hubbub, and order scale. *Journal of Applied Dev. Psych. 16*(3), 429-444.

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