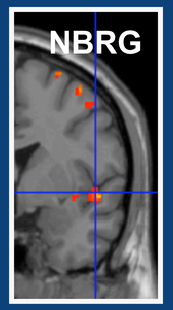
Enhanced attentional and viscero-integrative network activation in response to poverty-related image stimuli by low socio-economic status subjects: an emotional visual fMRI study

Michael Stitzer[1], Michael E. Silverman[1], Peter Muennig[2], Zohn Rosen[3], Thomas P. Naidich[1], Martin A. Goldstein[1]
[1]Mount Sinai School of Medicine, Mount Sinai Medical Center, New York
[2]Mailman School of Public Health, Columbia University, New York
[3]Department of Psychology at the Graduate Center, City University of New York



BACKGROUND

Low socioeconomic status (SES) is associated with increased morbidity.[1] Material deprivations account for only part of this association[2], prompting study of other ways SES impacts health. One candidate mechanism involves low SES-related psychological stress yielding deleterious somatic effects[3]. Confirming this would require extending insights derived from animal[4] and human models[5] involving environmental stress, and determining a mechanism by which low SES-related environmental stressors are neurally-transduced (akin to neuroimaging explorations of acute stressor responses, e.g., PTSD).[6]

OBJECTIVE

To use fMRI to explore the neural activation differences between low and high SES subjects during poverty-related visual stimulus processing.

SUBJECTS

- 23 African-American, right-handed, medically and psychiatrically healthy individuals were scanned. 7 subjects were subsequently removed from analysis due to excessive head movement.
- Final analysis included 8 high SES & 8 low SES subjects.

METHODS

SUBJECT CLASSIFICATION:

- **Demographic data**: Country of birth, location of residence, age, occupation, income, education, personal and parental home ownership.
- **Neuropsychological:** Perceived Stress Scale, Perceived Neighborhood Scale, MacArthur Ladder, Rosenburg Self-Esteem Scale, Comprehensive Quality of Life Inventory, Negative Life Events Scale, Social Status Index, Beck's Hopelessness Scale, Control, Hostility & Optimism.

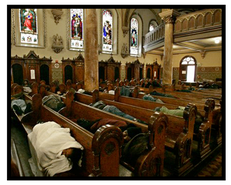
NEUROPSYCHOLOGICAL ACTIVATION PARADIGM:

- 2-alternative-forced-choice button press: one button corresponding to presentation of a pictorial image, another button to scrambled image
- Stimuli consisted of positive, negative, neutral images from the IAPS, scrambled images and custom poverty images validated in the same manner of the IAPS using 40 participants from impoverished neighborhoods in Manhattan, New York.
- Stimuli were presented in block design comprised of 40 total blocks (8 blocks per run, 5 total runs), pseudo-randomized and counterbalanced to control for order and time effects.
- Each block was composed of 10 stimuli picture/scrambled image (trials) of the same valence.
- 100 trials per condition, and 400 total trials per complete study session.
- Stimuli appeared for 1.5 second, followed by a jittered inter-stimulus interval (ISI) averaging 1900 msec., for a total block duration of 34 seconds. Each block was followed by 12 seconds of rest. Each run was preceded and followed by additional 36-second rest periods. Inter-run rest periods were variable, not exceeding one minute.

NEUROPSYCHOLOGICAL ACTIVATION PARADIGM (Cont.):

- Stimulus presentation and response collection were performed within the E-Prime environment
- Stimuli extended across entire screen subtending an average visual angle of approximately of 28° x 30°

Example Poverty Stimuli



NEUROIMAGING:

- Head-dedicated Siemens Allegra 3T MRI scanner.
- Structural images were acquired with a high-resolution T1-weighted SPGR sequence (resolution 256mm X 256mm for anatomic localization).
- T2*-weighted echo planar imaging (EPI) was used to obtain blood oxygen level dependent (BOLD) functional images. • TR=2000ms, TE=30ms, flip angle=90°, FoV=210 x 210; 32 slices; 3.0mm thickness; 1 mm skip gap; matrix=64x64.

DATA ANALYSIS:

- Image analysis was conducted with FSL using standardized steps of realignment, spatial smoothing with isotropic Gaussian kernel, and stereotactic normalization to standardized coordinate space (Montreal Neurological Institute Atlas within Talairach space).
- The first 2 time-points of each run, acquired for gradient stabilization, were discarded before analysis.
- Data was analyzed from the poverty image vs. neutral image contrast.
- Regions of interest were defined by clusters of ≥30 contiguous voxels revealing a significant difference in activation across conditions (Z>2.81, P<.005 two-tailed).

RESULTS

Relative to high SES, low SES subjects demonstrated greater occipital, anterior cingulate, thalamic, and insula activation while incidentally-processing poverty-related visual stimuli.

Cluster Region	Study-relevant Function	Talaraich Coordinates	Z-score	Image
occipital cortex	primary and secondary visual cortex	24, -96, 20 -26, -94, 18	3.41 3.38	1
anterior cingulate	attention, visual feedback	6, -16, 48 2, 16, 36	3.14 2.95	2
thalamus	attention, motor control	-12, -22, 2	2.74	3
insula	cognitive-emotional-visceral interface	35, 17, 12	2.26	4

RESULTS (Cont.)

note: all images presented at p≤0.05 for visualization

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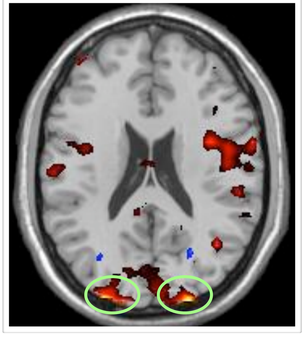

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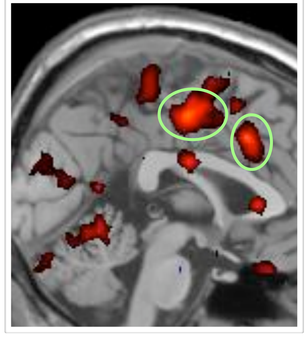

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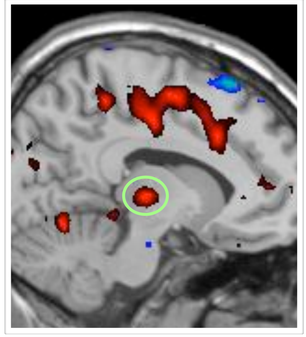

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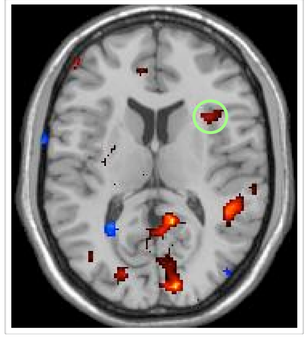

CONCLUSION

Low SES subjects demonstrated recruitment of a neural network containing attentional (cingulate, thalamus), visual (primary, secondary), and viscero-sensory integrative (insula) components during incidental processing of poverty-related visual stimuli. These results offer a potential neural mechanism mediating the transduction of environmental stressors into somatic changes within low SES populations.

References

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