Affective brain patterns as multivariate neural correlates of cardiovascular disease risk

Peter J. Gianaros\textsuperscript{a,b}, Thomas E. Kraynak\textsuperscript{a,b}, Dora C-H Kuan\textsuperscript{a}, James J. Gross\textsuperscript{c}, Kateri McRae\textsuperscript{d}, Ahmad R. Hariri\textsuperscript{e}, Stephen B. Manuck\textsuperscript{a}, Javier Rasero\textsuperscript{e}, Timothy D. Verstynen\textsuperscript{a,b}

\textsuperscript{(a) Department of Psychology (University of Pittsburgh) (b) Center for the Neural Basis of Cognition (University of Pittsburgh) (c) Department of Psychology (Stanford University) (d) Department of Psychology (University of Denver) (e) Department of Psychology and Neuroscience (Duke University) (f) Department of Psychology (Carnegie Mellon University)}

**Background and motivation**

- Existing evidence suggests that atherosclerotic cardiovascular disease (CVD) risk may relate to individual differences in the cortical and limbic brain systems that are implicated in encoding, processing, and responding to affective cues and contexts.
- One limitation of most studies of the neural correlates of CVD risk is their small sample sizes, which constrain attempts to cross-validate and replicate candidate brain biomarkers that are (a) stable across individuals and (b) generalizable to predict CVD outcomes in new and different samples. A problematic issue is that few studies have explored the psychometric properties of brain metrics (e.g., activation values) derived from neuroimaging tasks that are then used to predict CVD risk markers in statistical models.

**Goal**

Use of whole-brain and machine-learning methods to test whether individual differences in an indicator of preclinical atherosclerosis and CVD risk (carotid artery intima-media thickness; CA-IMT) are reliably associated with distributed brain activity patterns assessed by functional magnetic resonance imaging (fMRI) during affective information processing tasks.

**Methodology**

CA-IMT (y) was predicted from the evoked responses within gray matter voxels from all participant contrast maps (X) using a principal component regression with a 1.1 regularization (LASSO-PCR).

\begin{equation}
\hat{\beta} = \arg \min_{\beta} ||X - Z\beta||^2 + \lambda||\beta||.
\end{equation}

Both model optimization and generalization error estimation have been achieved using a nested cross-validation. For the outer loop, FACES task adopted a 5-Fold cross-validation, whereas IAPS task adopted a 2-Fold cross-validation based on study (PIP and AHAB-2). The inner loop for optimization was a 5-Fold cross-validation for either case.

Ancillary analyses included testing prediction power restricting and excluding the amygdala. Confounding effects were also studied, including age and sex as moderators of associations between predicted and observed CA-IMT, as well as similar tests of age, sex, and components of the metabolic syndrome as covariates.

**References**


**Take-home message**

We report the first cross-validated evidence in two large samples of adults for a specific and multivariate affective pattern of human brain activity that relates to individual differences in a vascular marker of cardiovascular disease (CVD) risk.

**Participants**

- Data derived from baseline (cross-sectional) assessments of participants from two studies: the Adult Health and Behavior project - Phase 2 (AHAB-2) and the Pittsburgh Imaging Project (PIP).
- The final total samples were N = 490 (AHAB-2) and N = 331 (PIP).
- Across both cohorts, participants' ages ranged from 30 to 54 years, with an approximate balance of men and women.

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