Integrated Multimodal Brain Signatures Predict Sex-Specific Obesity

Ravi R. Bhatt*[2], Newton Peng*[1], Soumya Ravichandran[1], Priten Vora, Jean Stains, Bruce Naliboff, Emeran A. Mayer[1], Arpana Gupta[1]

1G. Oppenheimer Center for Neurobiology of Stress and Resilience, Vachte and Tamar Manoukian Division of Digestive Disease, David Geffen School of Medicine at UCLA
2Imaging Genetics Center, Mark and Mary Stevens Neuroimaging and Informatics Institute, Keck School of Medicine at USC, University of Southern California
*Authors share co-first authorship.

Introduction

- Studies in obesity have individually used structural MR, functional resting state and diffusion tensor imaging to uncover mechanisms causing altered ingestive behaviors.
- Few have integrated data from multimodal brain imaging to predict sex-specific brain signatures.
- **Aim:** To investigate if a multimodal MR-clinical signature could predict people with obesity, dependent on sex-related differences.

Methods

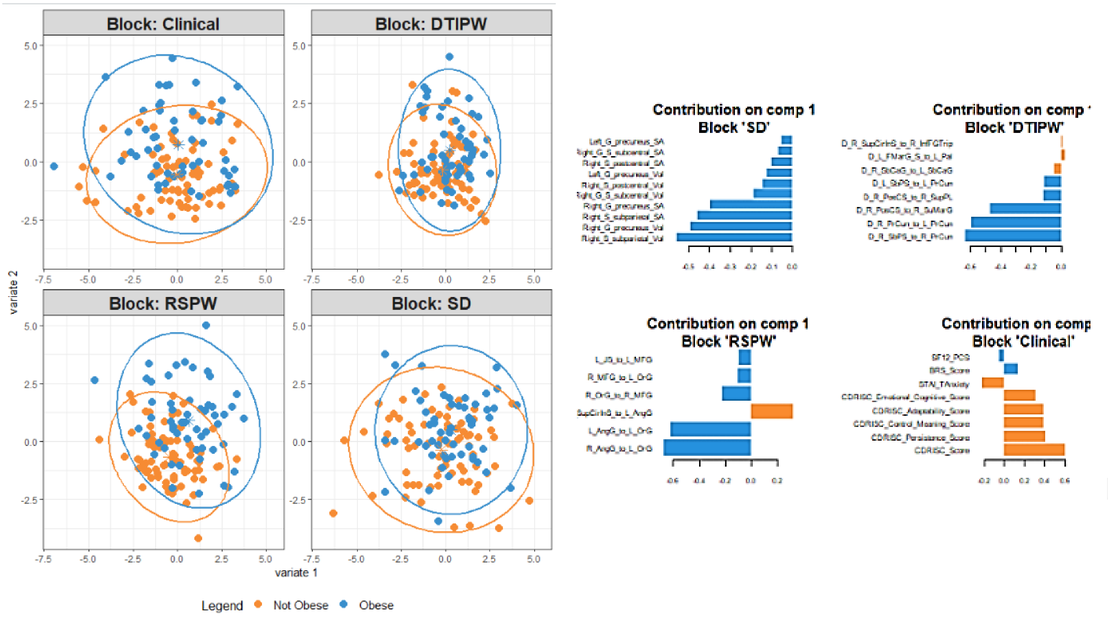
183 participants (Female=118; Male=65; Obese=78; Non-obese=105) underwent multimodal MRI scans.

DIABLO was conducted on training and test sets to determine whether clinical features, resting-state functional connectivity, anatomical connectivity and brain morphometry could accurately differentiate participants stratified by obesity and sex.

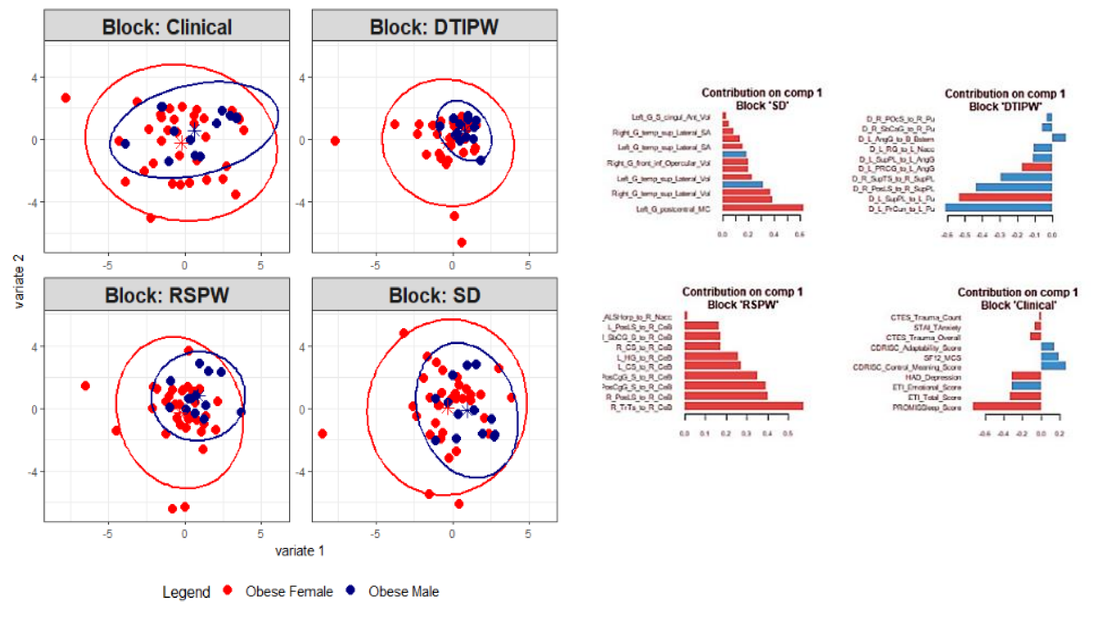
	Non-obese	Obese	Total
Male	42	23	67
Female	63	55	118
Total	195	78	183

Results

Model 1: Accuracy=74%, Kappa=46%, BER=26%



Model 2: Accuracy=74%, Kappa=40%, BER=32%



Discussion

Indicate that differences in morphometry and anatomical connectivity within the default mode network, and resting-state functional connectivity between the default mode network and orbital gyrus are able to distinguish people with obesity.

Inability to handle large cognitive loads could lead to lowered cognitive restraint and anxiety causing overeating behaviors seen in obese individuals.

Females with obesity had greater mean curvature in the postcentral gyrus and lateral temporal cortex and greater RSFC from the cerebellum to the SMN which were associated with greater likelihood of early life trauma and depression.

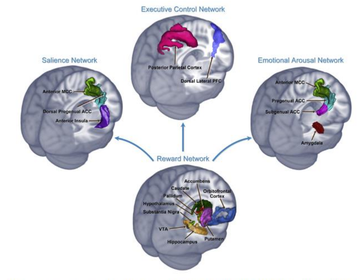


Fig. 1. Regions of the reward network and associated networks. 1. *Reward network*: hypothalamus, orbitofrontal cortex (OFC), nucleus accumbens, putamen, ventral tegmental area (VTA), substantia nigra, midbrain regions (caudate, pallidum, hippocampus). 2. *Salience network*: anterior insula, dorsal pregenual anterior cingulate cortex (dorsal pgACC), anterior mid cingulate cortex (aMCC). 3. *Executive control network*: posterior parietal cortex (PPC), dorsal lateral prefrontal cortex (dlPFC). 4. *Emotional arousal network*: pregenual anterior cingulate cortex (pgACC), subgenual anterior cingulate cortex (sgACC), anterior mid cingulate cortex (aMCC), amygdala.

References

Gupta, A., Mayer, E. A., Sanmiguel, C. P., Dinov, I. D., Tillisch, K., & Labus, J. S. (2014). Sa1355 Morphological Imaging-Based Brain Signatures Discriminate Overweight From Lean Subjects: Examining Central Mechanisms With Obesity. *Gastroenterology*, *146*(5). doi: 10.1016/s0016-5085(14)60957-4

Gupta, A., Mayer, E. A., Sanmiguel, C. P., Horn, J. D. V., Woodworth, D., Ellingson, B. M., … Labus, J. S. (2015). Patterns of brain structural connectivity differentiate normal weight from overweight subjects. *NeuroImage: Clinical*, *7*, 506–517. doi: 10.1016/j.nicl.2015.01.005

Rohart F, Gautier B, Singh A, and Le Cao K-A (2017) mixOmics: An R package for 'omics feature selection and multiple data integration. PLoS computational biology 13(11):e1005752

Lê Cao, K.A., Boitard, S., Besse, P., 2011. Sparse PLS discriminant analysis: biologically relevant feature selection and graphical displays for multiclass problems. BMC Bioinformatics 12, 253. http://dx.doi.org/10.1186/1471-2105-12-25321693065