Similarities in Brain Activation Patterns After Social Isolation and Food

Deprivation

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Background

- Main question: When people are isolated from one another for long periods of time, do they crave social interactions as they crave food after prolonged fasting?
- Methods: 40 participants underwent periods of social isolation and fasting. Then, they were placed in an fMRI machine to observe neural activity.
- Findings: The study's results
 concluded that periods of isolation
 induces social craving in the same
 way fasting can cause hunger.



Univariate Analysis

Question: What brain regions were similarly activated during CIC-task for social isolation and food deprivation sessions across subjects?

Methods:

- Acquire betas for isolation and fasting sessions
- Create a contrasts for social cue vs control during isolation session and s contrast for food cue vs control during fasting session
 - "Social contrasts" > a contrast between the social exposure and the control condition during the isolation session
 - "Food contrasts" > a contrast between the food exposure and the control condition during the fasting session





Tomova, Livia, et al. "Acute Social Isolation Evokes Midbrain Craving Responses Similar to Hunger." 2020, doi:10.1101/2020.03.25.006643.





Social > Control (p=0.05)

Food>Control (p=0.05)

Univariate Analysis: Discussion

Our own univariate analysis mostly reflects the findings presented by Tomova and colleagues. The research article emphasized similar activation of the substantia nigra and VTA across subjects, which we were able to confirm with our own analysis. Tomova and colleagues also tested for effects of cue on subregion of striatum, but found that "responses in the striatum and the rest of the brain were dissociable" (Tomova et. al.)

Pattern Similarity Analysis

Question: Does activation of dopaminergic reward circuit patterns correlate with one another when a subject longs for social exposure in the isolation condition with when a subject craves food in the food deprivation condition?

Methods:

- "Social contrasts" > a contrast between the social exposure and the control condition during the isolation session
- *"Food contrasts"* > a contrast between the food exposure and the control condition during the fasting session
- Parse the brain into distinctive ROI
- Conduct a cross-condition pattern similarity analysis
- Run a statistical analysis

Results/Conclusion:



*Statistically significant at a threshold of 0.01

Subjects demonstrated high correlation values in overlapping regions of the motor cortex, putamen, and the basal ganglia, which are related to motor learning, but also behaviors and emotions. Basal ganglia are interrelated with reward system activity, which indicates a potentially similar activation pattern among subjects that were both socially deprived and craved food, upon the presentation of the desired stimulus.



Pattern Analysis: Prediction Modeling

Question: Can we train a model to predict the brain state of reward, then use the model to support any of the study's hypotheses?

- Will the model support the idea that the cravings tasks elicited some brain state similar to reward? (as compared to the control tasks)
- Will the model support the idea that depriving the subjects of food or social interaction will make the type of stimulus of which they were deprived more rewarding? (compared to the non-deprived stimulus and the control)

Reward Localizer Model Accuracy

Model Details:

- Support Vector Machine (SVM)
- Cross-validated using 5 k-folds
- CV accuracy = 96%

What does this mean?

- Our model is (in this context), an almost perfect (96%) predictor of whether a stimulus is "rewarding"
- If found to correlate with other data, this similarity is almost certainly indicative of a similarity to "reward"

overall CV accuracy: 0.96



Pattern Analysis: Reward Localizer model



Pattern Analysis: Reward Localizer Model

Conclusions: This analysis supports that:

- The study paradigm was successful in that it:
 - Found a significant similarity between the brain states associated with the reward localizer task and the two tasks meant to elicit craving.
 - Found that this similarity was increased by depriving the subject of the supposedly rewarding stimulus prior to scanning.
- This means that: The data supports the idea that there is significant overlap between the systems that modulate different types of reward (specifically social, food and monetary rewards)



Inter Subject Representational Similarity Analysis

Question: Do subjects with more similar social connectedness measures demonstrate more similar patterns of neural activity when viewing social images after social isolation?

Methods:

Brain Similarity Matrix = Social Isolation Social Images v Baseline Social Images Behavioral score = Monthly Interactions, Close Relationships, Mean Social Network

Calculate Brain Similarity using correlation and euclidean distance Behavioral Similarity using euclidean distance

Loop over ROI and compute similarity between brain and behavioral measures

* Other contrasts were computed but no significant regions survived a threshold of 0.05

Inter Subject Representational Similarity Analysis Results:

Subjects with similar levels of social connectedness showed more similar patterns of neural activity in the VMPFC and orbitofrontal cortex. Similarity found in visual cortex may signify differences in scanning patterns.



* Not statistically significant at a threshold of 0.05 ** Regions found above at threshold of 0.1

Conclusion

Main results:

- A univariate analysis supported Tomova and colleagues' findings. More specifically, the analysis found similar activation of the SN and VTA during the isolation session when presented with a social cue and during the fasting session when presented with a food cue.
- Pattern Similarity Analysis showed that there were similar activation patterns in the basal ganglia across subjects that were socially and nutritionally deprived
- There is indication from the ISRSA that people who are more similar in social behavior showed more similar brain activity in VMPFC and OFC, but results were statistically insignificant. This may be due to lack of variance in the subjects or the lack of precision in the behavioral measure to probe social related brain areas