The Role of Semantic Inhibition in Creativity

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THE COGNITIVE COMPLEXITY LABORATORY

Introduction

Creativity has been linked to both uncontrolled associative processing and executive functions, such as inhibition.

The current study explore the neural networks underlying **spontaneous** and **controlled** associations and is trying to understand the mechanism underlying the phenomenon.

Method

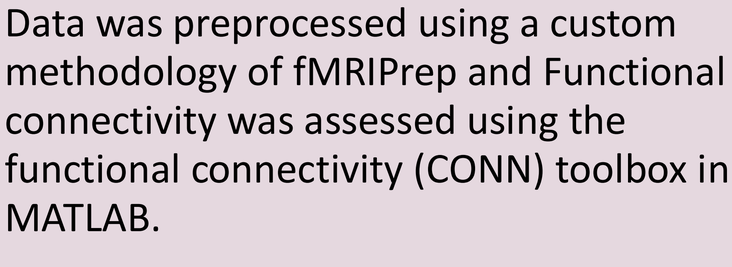
Participants: 40 participant (16 female; mean age = 23.32 y; SD= 4.8 ; mean years of formal education= 15 y, SD=1.3 y) were recruited.

MRI recording and analysis: MRI scanning was performed on a 3T Siemens Magnetom Prisma Fit MRI system (Siemens Medical Systems) using a 64-channel head coil, at the Technion MRI center.

Data was preprocessed using a custom methodology of fMRIPrep and Functional connectivity was assessed using the functional connectivity (CONN) toolbox in MATLAB.

Participants completed 4 tasks inside the scanner. Each task began with the presentation of common objects and was identical in structure, except for the final component. In the final part of each task, participants were instructed to either generate:

1. **Free associations (ASO)-** spontaneous
2. **Distant associations (DAT)-** controlled semantic inhibition
3. **Alternative uses (AUT)** - creativity
4. **Characteristics (OCT)**- control



Outside the scanner:

1. **Creative Achievements** (ICAA)
2. **Personality** (NEO-Five Factor Inventor - Big Five personality dimensions)
3. **Intelligence** (fluid and crystal intelligence)

Contact

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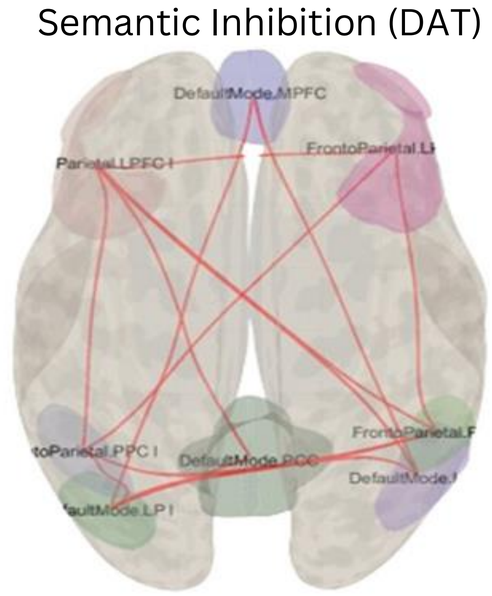
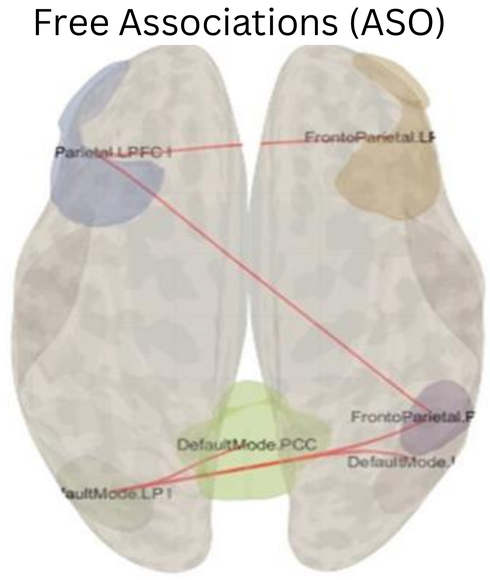
Neural Results (Task-Control)

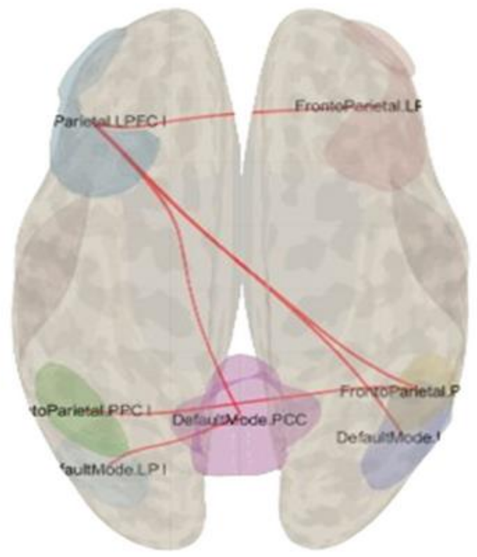
Semantic Inhibition (DAT)



Free Associations (ASO)



Alternative Uses (AUT)



We observed distinct patterns of brain network connectivity across the three cognitive conditions.

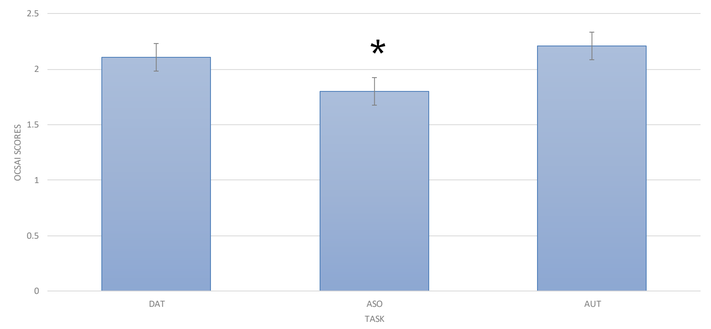
Semantic inhibition task : widespread connectivity was evident between regions of the Default Mode Network (DMN) and the Frontoparietal Control Network (FPCN), suggesting high integration and cognitive control demands required to suppress dominant semantic associations.

Free association task: elicited reduced and more localized connectivity, reflecting a relatively unconstrained retrieval state with minimal top-down modulation. This pattern was primarily associated with localized activation within the Default Mode Network (DMN), suggesting reliance on spontaneous internal processing with limited engagement of control networks.

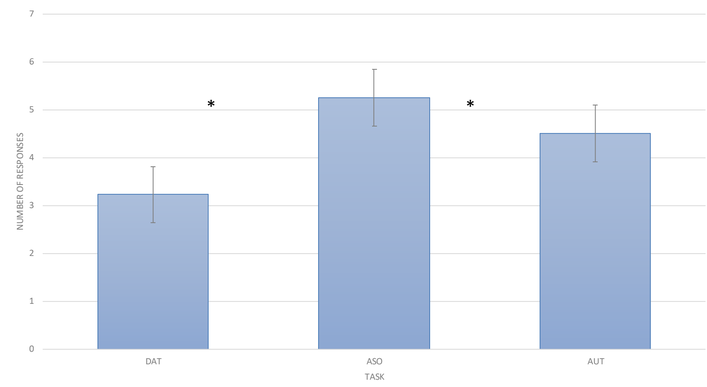
Alternative uses task: a measure of divergent thinking, revealed moderate cross-network connectivity—particularly between DMN hubs (e.g., PCC) and executive control regions—highlighting the dynamic interplay of spontaneous and controlled processes during creative ideation.

Behavioral Results inside the scanner

Originality

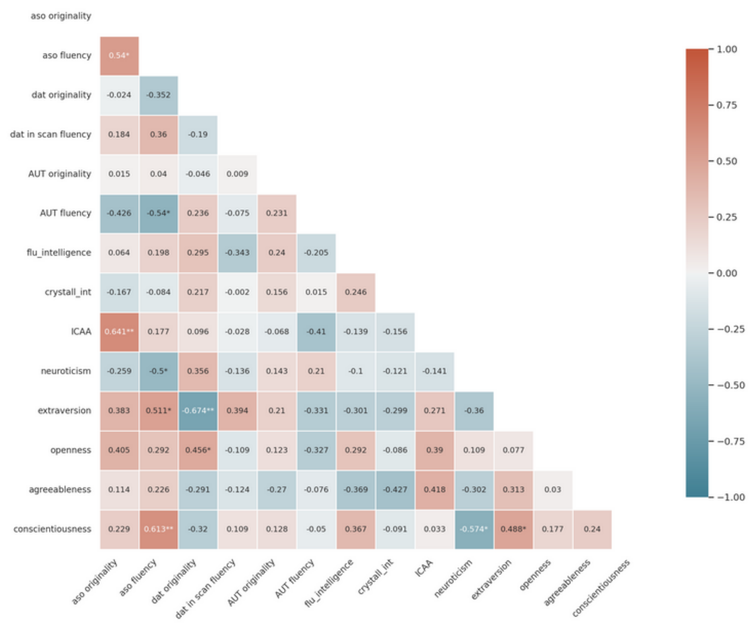


Fluency

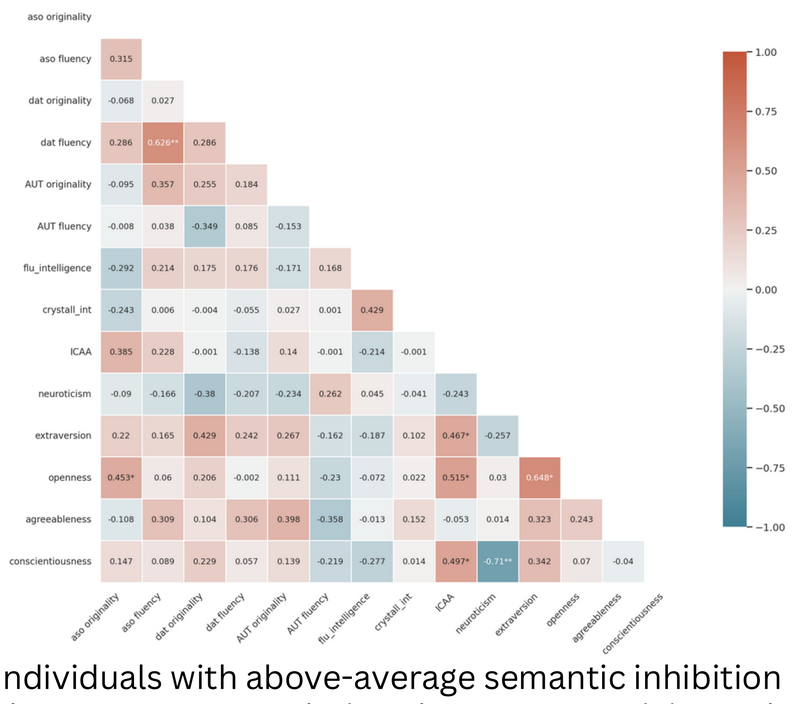


Correlations Analysis

Individuals with Semantic inhibition above average (N=19)



Individuals with Semantic inhibition below average (N=20)



Individuals with above-average semantic inhibition show stronger correlations between creativity and personality.

Individuals with below-average semantic inhibition is linked to looser, personality-driven patterns and emotional dysregulation.