Functional Connectivity of Co-localized Brain Regions during Biological Motion, Face and Social Perception using Partial Correlation Analysis

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BACKGROUND

Perception and recognition of actions and intentions of others is a complex cognitive process.

Such tasks require brain systems involved in

1) visual recognition

2) attention

3) cognitive control

Goals of this study:

1) identify the shared, distributed network involved in socially relevant information processing

2) determine the functional relationship among nodes within this distributed network

METHODS

Scanning: 16 subjects (8 males; 8 females)

UCI's Philips 3T scanner with parallel imaging (SENSE = 2.0).
Voxel size: 2.0 x 2.0 x 4.0mm; TR = 2s
Standard preprocessing in BrainVoyager QX

Stimuli and Task: Three localizers, all block designed

1) Localizer for Biological Motion Perception

Biological Motion   Scrambled Motion

16 sec   16 sec

Same or Different Actions?

2) Localizer for Face Perception

Static Face   Scrambled Face

Gaze   Identity   Pixel Scrambled

16 sec   16 sec   16sec

Same Gaze Direction   Same Identity

3) Localizer for Social Perception

Social   Mechanical

CONJUNCTION ANALYSIS

- Group GLM analysis to identify regions showing higher activation for each localizer

- Whole brain conjunction analysis (intersection) across all three tasks reveals coactivated regions of interest

PARTIAL CORRELATION: DEFINITION

Partial correlation represents the correlation between two variables after all common variance with other variables has been removed. The partial correlation expresses the correlation between the residuals

PARTIAL CORRELATION: ANALYSIS

For each invidual subject:

- Timeseries of each ROI extracted, with variance partitioned via partial correlation
  - Colored nodes: ROIs
  - Lines: connections, weighted by correlation strength
- Results:
  - The emergent connections that reveal new information shared between ROI pairs
  - Shown: Graphical representation of the partial correlation, averaged across subjects

TemporoParietal Regions

- Intra Parietal Sulcus (IPS)
- Sylvian Fissure (SyFis)
- posterior Superior Temporal Sulcus (STSp)

Prefrontal Regions

- Medial Pre-Frontal Cortex (MPFC)
- Insula (Ins)
- Inferior Frontal Gyrus (IFG)
- Pre-Motor Cortex (PMC)

Visual Areas
- hMT+
- Dorsal Occipital
- Ventral Occipital
- Fusiform Gyrus posterior (FGp)
- Fusiform Gyrus (FG)

Group Conjunction threshold
Bonferroni p > 0.05

CORE COMMON NETWORK

LH   RH

- Strong connections between homologous regions (connections across the hemispheres)
- Unique information within visual cortical connections and within prefrontal connections, each hemisphere
- Frontoparietal loop in the left hemisphere

- - - Negative partial correlation
——— Positive partial correlation

BIOLOGICAL MOTION

Left IFG   Right STSp

- More unique connections within Visual Areas
- Right STS connected to right Prefrontal regions

Left Ventral Occipital   Right Ventral Occipital

FACES

Left IFG   Right IFG

Right STSp

Left Ventral Occipital

- Right STS connected to prefrontal regions
- More unique connections within prefrontal regions

SOCIAL MECHANICAL

Left IFG   Right IFG   Right PMC

Right STSp

Left Ventral Occipital   Right Ventral Occipital

- New information shared within visual and prefrontal regions
- Bilateral connections between:
  - medial prefrontal and fusiform gyrus
  - parietal to ventral occipital, bilaterally

FUNCTIONAL CONNECTIONS

Correlation Analysis:

- Correlations between the timeseries of each ROI

Results:

- Most functional connections shared between at least two tasks

Bio & Social
Social
Face & Social
Face
Bio & Face
Bio
All

CONCLUSIONS

Partial Correlations analysis reveals:

1) A distributed network of brain regions for action & face recognition, and social cognition

2) A core pattern of connectivity shared between biological motion, face perception and perceived animacy

3) Unique patterns of connections for each task:

- Biological motion: new information constructed in visual cortex
- Face identification: STSp to Prefrontal to STSp connections
- Social cognition: many connections shared with biological motin and face recognition, plus unique connections between central visual cortex and prefrontal

These patterns of connectivity reflect the successful coordination of large-scale brain systems during social cognitive tasks.

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