Age differences in vmPFC functional connectivity during processing of socioemotional information

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Introduction

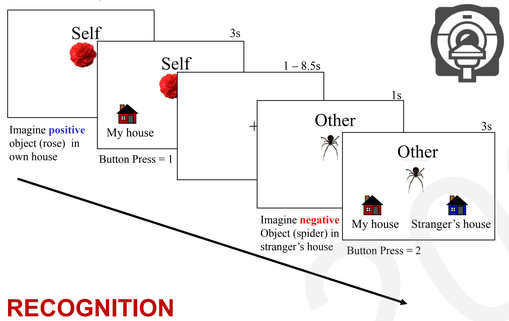
- The ventromedial medial prefrontal cortex (vmPFC) may serve as a site of shared processing for self-relevant and emotional information across in older adults (OA) and younger adults (YA).[1,2]
- Functional networks supporting self-relevant information processing show extensive overlap with the default mode network (DMN), whereas emotion processing tends to be associated with salience and executive control networks. However, vmPFC functional connectivity (FC) also shows fluctuations with the DMN during emotional information processing in social contexts.[3-5]
- Thus, it is unclear whether the vmPFC is functionally connected to a common network during the processing of self-relevant and emotional information or whether it acts as a hub that contributes to different functional networks.
- It is also unclear how increasing age is related to vmPFC FC due to age-related deterioration of DMN architecture as marked by weaker within-network FC[6] and stronger between-network FC between the DMN and externally oriented networks involved in cognitive control.[7,8]
- Hypotheses
  - Activation
    - OAs and YAs will show increased vmPFC activation for emotional and self-relevant information compared to neutral and non-self-relevant information
  - Functional Connectivity
    - During the processing of self-relevant and emotional information the vmPFC will be functionally connected to (H_{1a}) overlapping networks centered around the DMN or (H_{1b}) distinct, non-overlapping networks when processing these types of information.
    - Due to the cognitive benefits of self-relevance and emotional information with age, the vmPFC will be functionally connected to (H_{2a}) age-invariant networks when processing self-relevant and emotional information, or (H_{2b}) age-related changes functional networks will lead to decreased vmPFC-DMN region coupling for self-relevant information and increased vmPFC coupling with regions associated with cognitive control networks during the processing of emotional, non-self-relevant information.

Methods

Participants: 43 OA (27 female; age: mean = 68.28, s.d. = 6.78) and 50 YA (28 female; age: mean = 22.26, s.d. = 3.91)

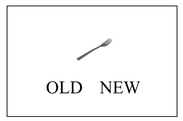
ENCODING

- Participants were presented with negative, neutral, and positive (n = 168) objects and were prompted to either imagine the objects in their house or yard, or a stranger's house or yard



RECOGNITION

- Studied items and an equal number of new items were presented immediately after encoding

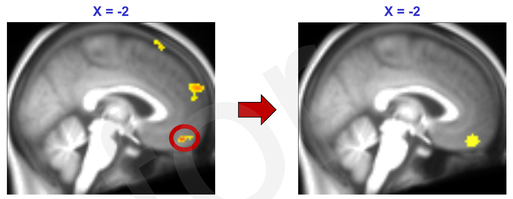


- There were no age differences in memory performance on this task and both age groups showed memory enhancements for self-relevant and emotional content.

FMRI ANALYSES

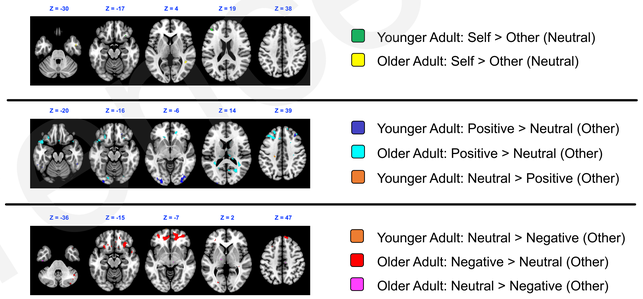
- Random Effects ANOVA (group level)
  - Within-subject variables:
    - Emotion (negative, neutral, positive)
    - Self-relevance (self and other)
  - Between-subject variable:
    - Age Group (YA and OA)
  - Defining vmPFC ROI:
    - *t*-contrast '*All Conditions > Neutral-Other*'
- Functional Connectivity Analysis (gPPI)
  - vmPFC seed (MNI: -2 46 -20)
  - *F*-tests (p = .005, k = 30)
    - Age Group * Self/Other (neutral content)
    - Age Group * Negative/Neutral (other content)
    - Age Group * Positive/Neutral (other content)
  - To determine whether *F*-tests reflected subtle age differences or highlighted the regions that show the greatest age differences in functional connectivity with the vmPFC we conducted conjunction analyses using directional *t*-contrasts (p =.005, k = 40; not masked with *F*-test for visualization purposes)

Age invariant activity during processing of self-relevant and emotional information

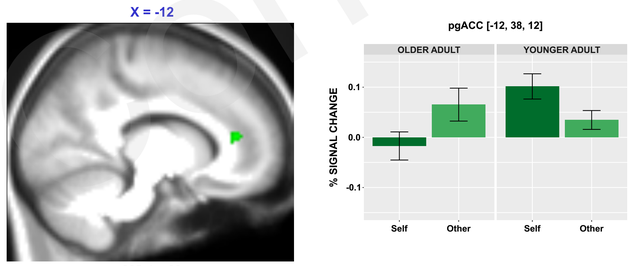


- Activation analyses reveal a common vmPFC cluster (circled in red) activated during the contrast '*All Conditions > Neutral-Other*' (left panel)
- This cluster was set as the seed region for functional connectivity analyses (right panel)

Minimal overlap reveals that age interactions reflect greatest differences in vmPFC functional connectivity



Age differences in vmPFC-ACC FC when processing self-relevant information

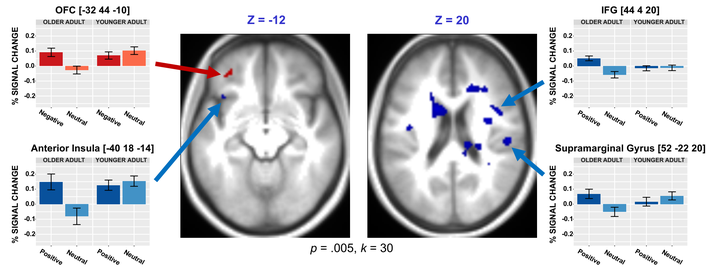


p = .005, k = 30

- There was a significant Age Group * Self/Other interaction in vmPFC-perigenual ACC (pgACC) coupling
- OAs showed positive connectivity between these regions for non-self-relevant information
- YAs showed positive connectivity between these regions for both self-relevant and non-self-relevant information, but stronger connectivity for self-relevant information

Age differences in vmPFC FC with regions associated with externally oriented networks when processing emotional information

- There was a significant Age Group * Negative/Neutral interaction in vmPFC-OFC coupling
- OAs showed positive connectivity for negative content
- YAs showed positive connectivity for both negative and neutral content



p = .005, k = 30

- There was a significant Age Group * Positive/Neutral interaction in vmPFC coupling with the anterior insula, IFG and supramarginal gyrus
- OAs showed positive connectivity for positive content, but negative connectivity for neutral content between the vmPFC and all three regions
- YAs showed positive connectivity for both positive and neutral content between the vmPFC and the anterior insula and supramarginal gyrus

Conclusions

- A common activation hub during the processing of self-relevant and emotional content in OAs and YAs, the vmPFC appears to be functionally connected to distinct networks during the processing of these types of content and age further effects the make up of these networks.
- Regions that showed the greatest age differences for self-relevance included regions associated with the DMN, while the largest age differences for emotion included regions associated with the salience and executive control networks.
- Recent work demonstrates integration between regions in the DMN and externally oriented networks may reflect adaptive processes in OAs during autobiographical memory.[9] Rather than age-related changes in vmPFC FC reflecting cognitive decline in our study, we speculate that integration between the vmPFC and regions outside the DMN may assist OAs in the mental representation of emotion content in social contexts.

References

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