Structural Anatomy of Empathy in Neurodegenerative Disease

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Introduction

- Empathy is the capacity to understand and share other people’s emotions
- Sympathy vs. Empathy:
  - Sympathy: having a feeling together with someone
  - Empathy: “entering” into another’s feeling
- Patients with neurodegenerative diseases (e.g., frontotemporal lobar degeneration) usually show lack of empathy

Previous studies:

- Studies examine functional neuroimaging show that empathy is derived from three cognitive processes (Decety & Jackson, 2004):
  1. others’ emotion is shared
     - parts of frontal and temporal cortices, etc
  2. recognize that the cause of such experience is from others not oneself
     - medial prefrontal cortex, etc
  3. intentional suppression of one’s own viewpoint
     - Brodmann’s area 10, etc

Functional neuroimaging was mostly done on healthy control subjects:

- Studies looking for patients with neurodegenerative diseases only received little attention
- Few patient studies showed that certain brain lesions lead to loss of empathy
- Cannot generalize the neural basis of empathy in all neurodegenerative patients

Hypotheses:

- Using different techniques to determine the degree to which regional difference in brain volumes correspond to empathic behavior

- Supply of the dorsomedial prefrontal cortex, the right posterior superior temporal sulcus and the right temporal pole correspond to empathic behavior
Methods

- 23 patients with neurodegenerative diseases (56% male and 41% female);
- 20 age-matched healthy subjects
- Informant rating:
  - Cognitive Empathy subscale
  - Perspective-taking (PT)
  - Emotional Empathy subscale
  - Empathic concern (EC)

Structural MRI was used to analyze the images for differences in volume of grey matter.
- Control the differences in age, sex and intracranial volume to test the main effect of empathy on grey matter volumes.

Results

Behavior Results

- Patients with frontotemporal dementia (FTD) or semantic dementia (SeDe) showed significant lower EC score than healthy control group.

Neuroimaging results

- Total empathy score is significantly correlated with difference in grey matter volumes in the right temporal lobe ($z = -25, -33, -35$)
- Right fusiform gyrus ($z = 41$)
- Right medial inferior frontal region ($z = -3$)

Behavioral results

- Patients with FTD, SeDe or Alzheimer’s disease (AD) had significantly lower PT score than the control group.

Neuroimaging results

- Total empathy scores is positively correlate with voxel intensity.
Results
- Main effect of emotional empathy include voxels at right temporal lobe, right caudate/subcallosal gyrus and right inferior frontal gyrus.
- Main effect of cognitive empathy also include the first 2 regions and also the anterior/posterior fusiform gyrus.

Discussion
- Lower level of empathy corresponded most significantly with atrophy of the right temporal lobe, right anterior fusiform gyrus, and the right medial inferior frontal cortex.
- Parts of their hypotheses were supported!!

Discussion
- Structures of the temporal lobe:
  - Both left and right temporal poles were functionally recruited when controls perform empathic task (Reiman et al., 1997).
  - Previous study suggested that right temporal pole creates symbolic socio-emotional rules that aid face recognition (Mesulam, 1998).
  - Fusiform gyrus involves face perception and recognition which are skills necessary for empathy (Lewis et al., 2003).

Discussion
- Structures of the frontal lobe:
  - The postero-medial area of orbitofrontal cortex (OFC) is significantly related to emotional empathy (Kringelbach & Rolls, 2004).
  - Patients with OFC lesion showed deficits in emotion recognition, both facial and vocal (Adolphs et al., 2000).
  - Subcortical structures like ventral striatum has similar function as OFC (Breiter et al., 2001).
  - Dorsomedial frontal structures are involved in the perspective taking aspects of empathy (Farrow et al., 2001).

Opinions
- Strength:
  - Large sample size.
  - Include patients from various neurodegenerative groups.
  - Provides data to support and test the finding from previous functional studies.

Limitation:
- Average age for subjects were quite high (M = 63.4).
- Use TMS to test similar effect in younger age group.
- The techniques and images are quite difficult to understand at first.

Thank you! Question?? No...please??...