Brain Function in Autism Spectrum Disorder

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Cardinal Features of ASD

1. Social communication deficits
2. Restricted repetitive stereotyped behavior

Cognitive Psychopathology of ASD

“Theory of Mind”

- Theory of Mind refers to the ability to represent the mental states of others
- Theory of Mind allows the attribution of mental states to self and others to explain and predict behavior.

Theory of Mind

- The person with autism spectrum disorder may not recognize the cues that indicate the intentions or feelings of the other persons or know how to respond.
- This has been described as ‘mind blindness’

Joint Attention

- Infants achieve considerable skill at following another's direction of gaze, thereby focusing on the other person's object of attention (Adamson 1985).
- Children with ASD have some problem in following others' gaze

Face Processing

- Faces are remarkably homogenous and share a highly similar structure:
- Consisting of the same parts (eyes, nose)
- In the same basic configuration (nose below the eyes).

Face Processing

- Development brings an increasing ability to process faces configurally rather than in a piecemeal fashion (Gauthier 2000).

Face Processing

- Inattention to face is a developmentally primary symptom of autism that is apparent in infancy (Osterling 2002).
- Individuals with autism are impaired in holistic face recognition processes,
- and instead rely on feature-or part-based face recognition strategies.

Face Processing

- Individuals with autism pay particular attention to the mouth instead of the eye region of faces (Klin, 2002).

Face Processing

- It has also been shown that they are less able to read the meaning in the eyes than control subjects (Baron –Cohen, Jolliffe 1997; Baron – Cohen, et al. 2001).

Facial Expression

- Children as young as a few months old have been shown to be able to discriminate happy and sad faces from surprised faces

Facial Expression

- In normal children, emotion decoding improves throughout much of childhood (Vicari et al. 2000)
- and into adolescence **(Thomas et al. 2007).**

Facial Expression

- Facial emotion recognition (FER) improves less over time in children with ASD than in typically developing children.
- In one study of young children, FER performance was correlated with age in the TD, but not the ASD group (Gepner et al. 2001).

Facial Expression

- Many studies find reduced accuracy in identifying emotions in individuals with ASD, especially for negative emotions (Ashwin et al. 2006; Bal et al. 2010).

Neural systems Impaired in ASD

Neural systems Impaired in ASD

- Brain network involving :
- occipitotemporal cortex,
- superior temporal regions,
- amygdala,
- frontal cortex,
- and somatosensory cortex
- are involved in processing social information, in particular emotions and direction of eye gaze, from the face.

Neural systems Impaired in ASD

- we reviewed 292 task-based fMRI studies on ASD individuals.
- We observed that face perception, language, attention, and social processing tasks were mostly studied in ASD.

Neural systems Impaired in ASD

- In addition, 73 brain regions, estimated as about 83% of brain grey matter, showed an altered activation between the ASD and normal individuals during these four tasks, either a lower or a higher activation *(Batouli et al 2023)*

Social Stimuli

- In this systematic review *(Batouli et al 2023):*
- Thirty brain areas showed a different activation between cases and controls during the processing of social stimuli and tasks;
- 21 of them only showed lower activation in patients,
- 1 had a higher activation,
- and 8 areas had both lower and higher reports.

Social Stimuli

- The most brain areas with a lower activation in patients were temporoparietal junction,
- inferior frontal gyrus,
- superior temporal gyrus,
- medial prefrontal,
- anterior cingulate cortex, posterior cingulate cortex,
- inferior parietal lobule,
- ant. insula, caudate

Social Stimuli

- while doing theory of mind task (Eyes Task),
- reduced activity in medial prefrontal cortex
- Decreased activity in left inferior prefrontal gyrus,
- orbitofrontal cortex,
- temporopolar and
- middle temporal gyrus

Social Stimuli

- during the attentional orienting triggered by eye gaze:
- Amygdala showed a lower activation (Klapwijk, E. T. *et al 2016)*
- The decline of activation in the hippocampus also suggests problems in integrating emotional information with declarative memory *(Klapwijk, E. T. et al 2016)*

Social Stimuli

- Superior temporal gyrus is active in tasks involving the attribution of intentions to moving geometric figures, as well as in social dysfunction in autism *(Pelphrey, K. A. 2007)*

Face Processing

- In facial identity processing and FER in ASD,
- decreased fusiform gyrus (FG) activation is a common finding (Hubl et al. 2003).
- Reduced amygdala activity is a common finding on both neutral face processing (Hadjikhani et al. 2007)
- and FER (Ashwin et al. 2007;) in ASD.

Face Processing

- when processing faces,
- forty brain regions showed a different activation between cases and controls.
- Sixteen areas only showed a lower activation,
- 7 areas only a higher activation,
- and 17 areas showed both lower and higher activations *(Batouli et al 2023).*

Face Processing

- when processing faces,
- Fusiform gyrus, as well as the amygdala,
- superior temporal gyrus,
- ventromedial prefrontal cortex,
- occipital face area,
- inferior frontal gyrus,
- insula,, cuneus, hippocampus, and striatum,
- showed lower activation in the ASD group *(Batouli et al 2023).*

Face Processing

- It has been reported that amygdala has higher, lower, and no difference in activation between the ASD and healthy andividuals in face processing.
- The reasons for the inconsistent findings could be due to the differences in attention to the faces
- or the type of tasks and stimuli.

Emotion Processing

- In emotional face processing while seeing fearful faces ,
- Reduced activity in ventromedial prefrontal cortex (vmPFC)
- decreased activity in right superior temporal sulcus,
- and right inferior frontal gyrus

Emotion Processing

- while processing emotional faces,
- Reduced activity in right fusiform face area,
- right occipital face area (OFA),
- left amygdala, left putamen,
- and the posterior cingulate cortex (PCC) Increased activity in subcortical face processing system (superior colliculus, pulvinar nucleus of the thalamus and amygdala)

Emotion Processing

- While viewing emotional faces,
- individuals with ASD also exhibit decreased activation in the cerebellum (Critchley et al. 2000),
- medial-frontal and orbito-frontal cortices (Loveland et al. 2008),
- and inferior frontal gyrus (IFG) (Greimel et al. 2010) compared to TD controls.

Emotion Processing

- in response to dynamic versus static facial expressions,
- reduced activation of several brain regions has been found in the ASD group compared with controls,
- including the middle temporal gyrus (MTG),
- fusiform gyrus,
- amygdala,
- medial prefrontal cortex, and inferior frontal gyrus (IFG) (Wataru Sato 2012).

Connectivity

- researchers have reported altered functional connectivity, in certain regions in ASD when viewing emotional faces.

- Monk et al. (2010) found decreased functional connectivity between the medial temporal gyrus and right amygdala in ASD during the perception of emotional faces

Connectivity

- Decreased effective connectivity between some brain areas and inferior frontal gyrus
- There was a relationship between the decreased connectivity in posterior cingulate and impaired social functioning *(Batouli et al 2023)*

Connectivity

- Decreased functional connectivity in areas required for theory of mind processing
- Decreased functional connectivity between ventral premotor cortex and the ToM network

(Batouli et al. 2023)

Connectivity

- Decreased connectivity in posterior limbic and sensorimotor
- Decreased connectivity in areas of default mode network
- Reduced connectivity between amygdala and cortical areas
- Increased activity in visual cortex

Connectivity

- Impaired connectivity between the cerebellum and TPJ
- Decreased connectivity between anterior and posterior areas
- Reduced connectivity in areas related to face processing
- Impaired functional connectivity in areas of social processing

Connectivity

- Wicker et al. (2008) reported abnormal effective connectivity between pre-frontal and posterior temporal regions in ASD during an facial emotion recognition task

Connectivity

- bi-directional effective connectivity involving the primary visual cortex
- –medial temporal gyrus
- –inferior frontal gyrus circuit was enhanced in response to dynamic as compared with static facial expressions in the control group
- all these modulatory effects were weaker in the ASD group than in the control group (*Wataru Sato 2012*).

Connectivity

- Overall, brain regions with reduced activation,
- regions with increased activation,
- and abnormal connectivity between regions during social tasks in ASD suggest
- abnormality in the circuitry of the **social brain**

autism
accept different.

Thank You for Your Attention