Time-Resolved Analysis of Delayed fMRI Signal Change During Social Evaluative Feedback Processing in the Adolescent Brain

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Social rejection can be highly distressing and can play a role in developing psychopathology. Knowing how social rejection processing occurs in the brain is important for understanding and treating its consequences. However, brain activity associated with social rejection processing has not yet been identified; possibly caused by time-restricted analyses. The current study examined the neural activity for social rejection feedback processing with traditional and time-specific analyses.

Background

Prior neuroimaging work on social evaluation:

- The anterior cingulate cortex (ACC) is differentially involved in the processing of social evaluative feedback[1].
  - Dorsal ACC (dACC) for incongruent feedback (incongruent > congruent)[1];
  - Ventral ACC (vACC) for positive feedback (acceptance > rejection)[1];
- Brain areas are found to be activated for expected negative feedback (vPFC, subcallosal cortex, caudate, putamen, midfrontal gyrus for expected rejection > unexpected acceptance)[2], yet no increased activity for (unexpected) negative feedback has been found so far.
- In contrast, many studies have found activity in a 'social pain network' after social exclusion (cyberball)[3]. It is puzzling that this has not been found for social rejection.
- Typically, neural activity after social rejection is modelled using the canonical HRF (cHRF) function within 2.2 sec after feedback presentation. This method precludes from finding effects that occur at later stages during feedback processing.
- Neural social rejection feedback processing can possibly occur with a delay. This might be captured with time-resolved analysis.

Hypothesis:

- Delayed fMRI signal change of social rejection feedback processing after the traditional 2.2 sec could be captured by Finite Impulse Response (FIR) modelling by placing less constraints on shape and timing of the BOLD response.

Method

Social Judgment Paradigm[1]: (Fig1)

- Social rejection or acceptance feedback, expected or unexpected.

Participants:

- N = 53; ages 8-25; 47% male.

Re-analysis of Gunther Moor. et al. (2010)[2]: (Fig 2)

- cHRF.
- FIR in 4 time bins.

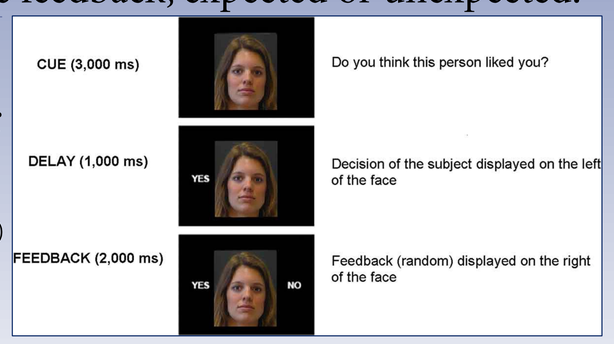

Figure 1. Example trial of Social Judgment Paradigm[2]

Whole-brain:

- Delayed neural activity might occur in areas previously unassociated to social pain.

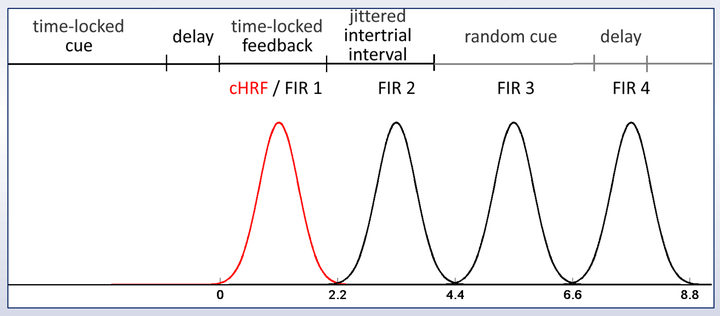

Figure 2. Timing of the trials visualizing the BOLD response in the cHRF and FIR time bins.

ROI's: (*a-priori* selected; Fig3)

- 'Social pain network' as template: dACC, AI & vPFC[3].
- Added vACC[1], as it might be a part of the 'social pain network'[4].

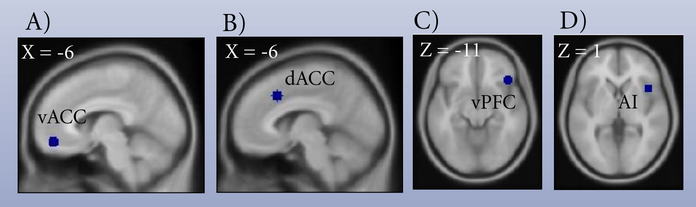

Figure 3. Selected regions of interest (ROIs): A) Ventral anterior cingulate cortex; B) dorsal anterior cingulate cortex; C) ventral prefrontal cortex; D) anterior insula

Results

Whole-brain:

for unexpected social rejection feedback
($p < .001$, 10 contiguous voxels)

- cHRF: (Fig 4A) vPFC activity.
- FIR: (Figs 4B-D) Activity in delayed time bins 2-4.

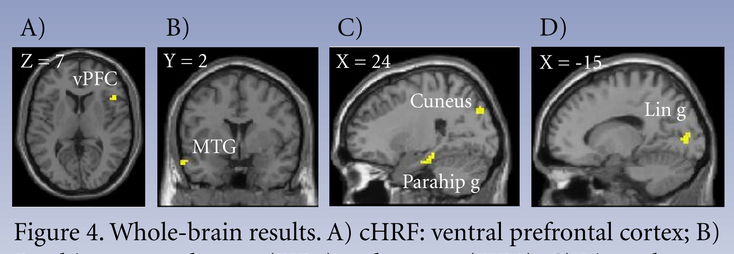

Figure 4. Whole-brain results. A) cHRF: ventral prefrontal cortex; B) Parahippocampal gyrus (FIR4) and cuneus (FIR3); C) Lingual gyrus (FIR2); D) Middle Temporal Gyrus (FIR4).

ROI's: (*a-priori* selected)

- No activity in the 'social pain network' associated with social rejection feedback.
- vPFC: Immediate (cHRF; Fig5A) and delayed (FIR 4; Fig 5B) increase for incongruent feedback.
- vACC: Delayed recovery to baseline for social rejection (Fig 6).

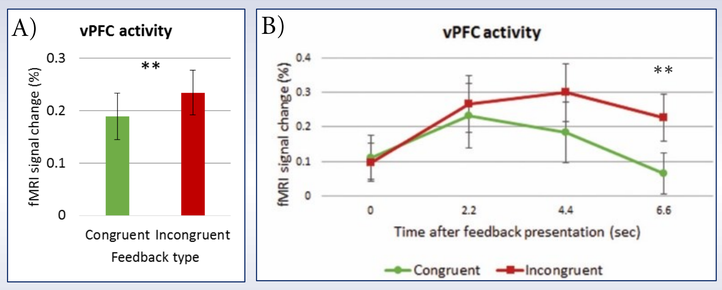

Figure 5. vPFC activity modelled with A) cHRF, $^{**}p = .002$; B) FIR, $^{**}p = .007$.

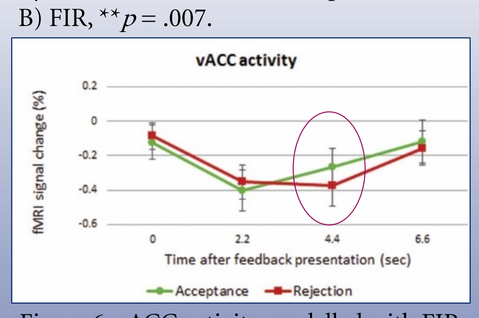

Figure 6. vACC activity modelled with FIR.

Conclusion & Discussion

- cHRF results showed vPFC activity (whole-brain) for unexpected social rejection feedback, but this might be caused by incongruence.
- FIR results showed additional activity (whole-brain) in regions not found using cHRF modelling, identifying delayed neural responses.
- Brain regions typically implicated in the 'social pain network' (ROIs studied here) were not significantly activated during the processing of social rejection feedback.
  - Could be caused by differences between paradigms and/or neural activity associated with social rejection vs. exclusion.
- Additional ROI results:
  - The vPFC was sensitive to incongruent social feedback.
  - The vACC showed a delayed recovery to baseline activity after rejection feedback.

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