Effect of Reward Seeking Behavior on Neural Activation in Response to Reward

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Background

- Effect of maternal depression can be seen in children early on, yet the exact mechanism is unknown *(Goodman et al., 2011)*
- Altered reward functioning in depression is associated with anhedonia, a key symptom *(Der-Avakian & Markou, 2012)*
- Possible dysfunction in reward processing of pre-pubertal children at high risk for depression is not previously studied

Hypothesis 1: Children at risk for depression would show decreased reward seeking behavior

Hypothesis 2: Children at risk for depression would show blunted neural response to rewarding stimuli

Hypothesis 3: Decreased reward seeking behavior would be associated with blunted neural response to reward

Methods

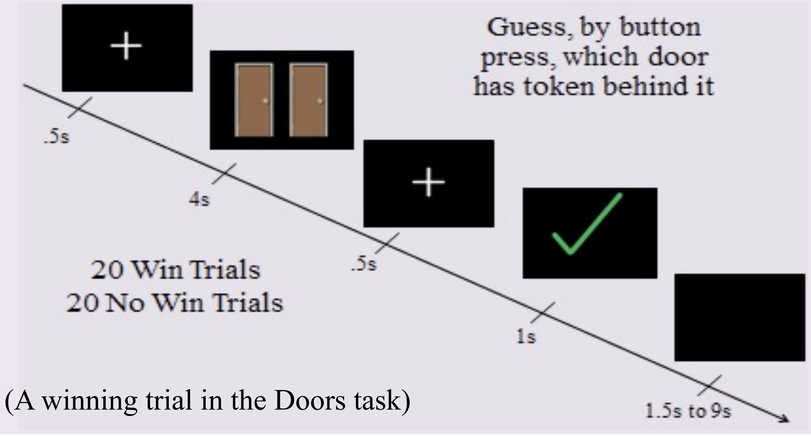
- 22 healthy six to eight year old children, 15 female
  - 10 with depressed mother (high risk; HR), 12 non-depressed (low risk; LR)
- Mother and child psychiatric history determined from clinical interview conduced by trained interviewers

Progressive Ratio (PR) Schedule

- Press button multiple times to burst balloon
- One token won for each balloon that is popped
- More presses to pop balloon for each subsequent round
- Measures reward seeking behavior and effort to obtain reward

Doors Task

- fMRI guessing game with predetermined outcome
- Win > no win trials used as a measure of neural activation in response to reward



(A winning trial in the Doors task)

Methods (cont.)

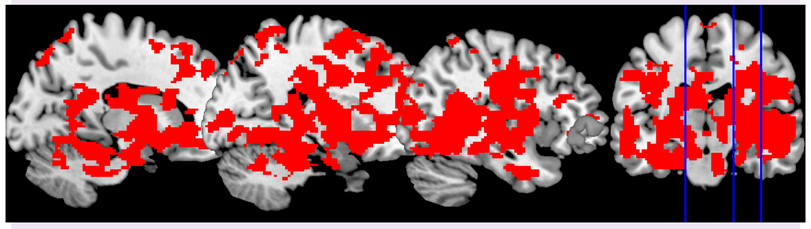
Data Analytic Strategy

- Hypothesis 1: Independent sample t-test of tokens won in PR
- Hypothesis 2: Group difference model conducted in SPM8
  - HR < LR during win > no win comparisons in Doors
- Hypothesis 3: Regression model in SPM8
  - Tokens won in PR regressed on win > no win in Doors
- For hypotheses 2 & 3, used whole brain analyses and corrected for multiple comparisons using Alpha Sim at $p < .05$ (600 voxels)

Results

Task Effects –

- Winning trials in the Doors task activated many reward related regions, including the ventral striatum, orbitofrontal cortex, medial prefrontal cortex and posterior cingulate cortex

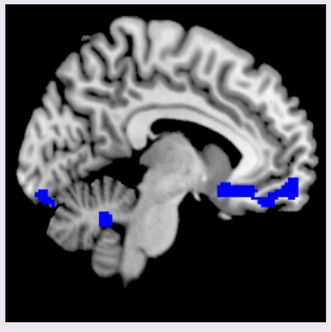


Hypothesis 1 –

- No significant difference in reward seeking behavior across high and low risk children as measured by tokens won during PR schedule ($F = 3.31$, $p = 0.08$)

Hypothesis 2 –

- HR children showed less activation than LR children in the orbitofrontal cortex (OFC) during Doors wins

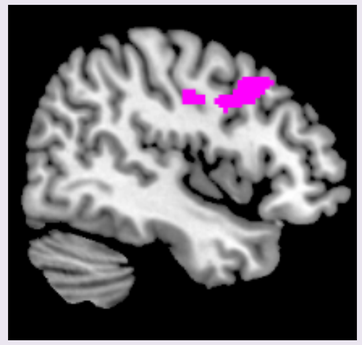


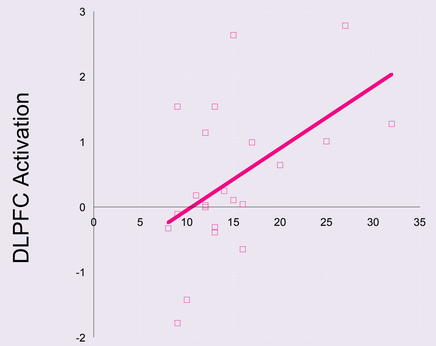
OFC, 5490 voxels, [34, 12, -22], $t = 4.38$

Results (cont.)

Hypothesis 3 –

- In both groups, less reward seeking behavior on the PR schedule was associated with less activation in the dorsolateral prefrontal cortex (dlPFC) when winning rewards in Doors





dlPFC, 1000 voxels, [52, 12, 42], $t = 4.69$ Behavioral Reward Seeking on PR Schedule

Discussion

- OFC function in stimulus-reinforcement association and reward pleasure *(Rolls, 2004)*
  - Blunted function in OFC of HR children may suggest less pleasure association when receiving reward
- dlPFC role in representation of goals and reward information *(Ballard et al., 2011)*
  - Blunted activation in less reward seeking children may be associated with less motivation for children to seek rewards
- Neural differences between HR and LR children seen, but not behavioral differences
  - May suggest that altered brain function manifests early, whereas behavioral changes may not emerge until later years
- Findings can aid early detection and potential prevention of depression
  - Counter initial feelings of anhedonia with focused therapies creating appropriate associations with rewarding stimuli
  - If caught early enough, could potentially result in healthy reward processing