

Investigating reward-related functional connectivity in late adolescents through an N-back task using functional MRI

Siti Hajar Zabri, Abdul Rahman MR, Aini Ismafairus Abd Hamid, Ahmad AH

School of Medical Sciences, School of Medical Sciences, Universiti Sains Malaysia, Kelantan, Malaysia

ABSTRACT

Introduction: Rewards processing is a fundamental aspect of human behaviour, with implications for motivation, decision-making and social interactions. While previous studies have explored how the brain responds to rewards in general, few have investigated how the specific recipient of the reward (self-versus others) impacts the connections within the brain's reward network. This study investigates reward-related functional connectivity (FC) differences between individuals motivated to win rewards for themselves and those motivated to win rewards for their parents. **Materials and Methods:** Twenty-eight healthy Malaysian participants (mean age 22.71 ± 1.14) underwent fMRI while performing an N-back task associated with different reward cues: self-reward, parental reward, certificate reward, and a neutral cue. Participants were divided into two groups (n=14 each) based on their highest performance on the N-back task: the "cash group" (motivated by self-reward) and the "filial group" (motivated by parental reward). FC analyses, utilizing the Conn Toolbox, focused on the nucleus accumbens (NAcc) as the seed region due to its central role in reward processing. A two-sample t-test with peak voxel and cluster size activation thresholds set at $p < 0.001$ and $p < 0.05$ respectively was conducted to identify significant differences in FC between the groups. **Results:** Filial motivation, compared to self-reward motivation, was associated with distinct patterns of functional connectivity during the N-back task. The filial group exhibited significantly increased functional connectivity (FC) between the left NAcc and the left precuneus when anticipating rewards for their parents (peak MNI coordinate: 8, -54, 18; $t(185) = 5.34$, $p < 0.05$), suggesting the engagement of brain regions involved in mentalizing and perspective-taking. Precuneus is a region previously found to be involved in self-referential processing and perspective-taking which is also related to empathy. Additionally, during the n-back task after the neutral cue (when no specific reward was anticipated) condition, there was a significant increase in FC between the left NAcc and left superior frontal gyrus in the filial group compared to the cash group (peak MNI coordinate -10 38 58, $t[118] = 5.28$, $p < 0.05$). This finding implicates enhanced integration of reward signals with cognitive control processes in the filial group, even in the absence of immediate external rewards. **Conclusion:** These findings provide novel insights into the neural mechanisms underlying reward processing in late adolescence, highlighting the influence of social factors, particularly the motivation to benefit family members, on the brain's reward system. The observed differences in FC may contribute to our understanding of how individuals weigh personal gain against the well-being of others, with potential implications for educational and clinical interventions targeting motivation and prosocial behaviour.