

Neural Activation for Emotional Induction: Differential Responses as a Function of Impulsivity and Reward-Sensitivity

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Sensation seeking is a biologically based personality trait defined as the tendency to seek varied, novel, and complex sensations and experiences, along with the willingness to take risks for the sake of such experiences (Zuckerman, 1994). Persuasive evidence links sensation seeking with initiation, escalation, and development of problems associated with drug use. A previous study by our group investigated the neural correlates of emotional reactivity in sensation seeking. High sensation seekers showed a greater fMRI response to high-arousal stimuli in brain regions involved in arousal and reinforcement, while low sensation seekers showed stronger activation and an earlier onset of fMRI response to high-arousal stimuli in regions associated with emotional regulation. Hence, high sensation seekers exhibit neural responses consistent with an overactive approach system and low sensation seekers exhibit a stronger inhibitory system response (Joseph et al., 2009).

Using the Zuckerman-Kuhlman Personality Questionnaire (ZKPQ) subjects were classified into four groups. The first group included participants who scored low on both reward sensitivity and impulsivity questions on the ZKPQ measure. The second group scored low in reward sensitivity but high in impulsivity. The third group scored low in impulsivity but high in reward sensitivity. The last group scored high in both categories: reward sensitivity and impulsivity. The latter group is thought to be the most likely to engage in risky behaviors, but the present design permits us to examine both impulsivity and reward-sensitivity dimensions independently as well as their interaction.

Each subject completed an Emotional Induction task using the International Affective Picture System (IAPS) (Lang et al 1999) while in the fMRI scanner. Each IAPS picture has been rated for arousal and valence and they strongly evoke activation in areas involved in emotional processing. The stimuli were categorized into four groups: high arousal positive, high arousal negative, low arousal positive and low arousal negative. This enabled us to examine arousal and valence dimensions separately. Activation patterns in response to the IAPS pictures illuminate cognitive processes such as emotional decision making, emotional regulation and cognitive control. These processes are likely to be factors that predispose individuals to participating or not participating in risky behaviors such as drug use.

Group differences emerged among the four subject groups. The high impulsive-low reward group had stronger fMRI responses overall compared to the other three groups in medial prefrontal cortex, caudate, and amygdala / hippocampal regions. These regions have been implicated in both affective and reward processing. In a different set of regions, (the left and right anterior cingulate and left medial superior frontal gyrus), the high impulsive-low reward group showed much greater activation for positively valenced pictures compared to other groups, but the groups did not differ in emotional response to negative pictures in these same regions. These regions have been implicated in control of emotional behavior. We speculate the greater engagement of emotional regulation regions in the high impulsive-low reward group may reflect greater effort in regulating the strong responses in limbic structures.