Neural Differences between Intrinsic Motivation and Incentive Motivation

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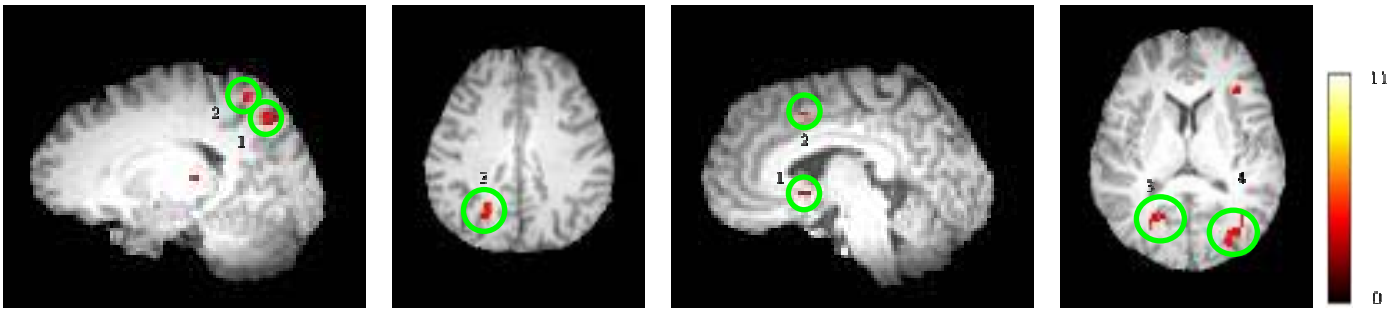
Purpose. As a field, motivation focuses on how behavior becomes energized and goal-directed. Motivation-oriented neuroscientists tend to focus rather exclusively on how the person's exposure to environmental incentives energizes and directs their brain activations and behavior with "incentive motivation." Social psychologists, however, argue that different types of motivation exist, and that the effort to distinguish between different types of motivation is important not only because different types of motivation have different origins and outcomes but also because environmentally-generated sources of motivation (i.e., incentive motivation) lead to relatively poorer functioning that do person-generated sources of motivation (i.e., intrinsic motivation; Ryan & Deci, 2000). While neuroscientists generally resist this distinction, the purpose of the present paper was to document for the first time the neural differences underlying activated intrinsic motivation from activated incentive motivation.

Method. Ten neurologically healthy and right-handed undergraduate students (4 females and 6 males; mean age: 19.7 ± 0.87) participated in this study. They were recruited from introductory educational psychology classes at the University of Iowa. The participants were asked to decide whether they wanted to do activities while reading sentences describing the activities. 60 sentences for each of the three conditions, intrinsic motivation, incentive motivation, and neutral motivation, were randomly distributed into three runs. Each run took 600 seconds which consisted of three-second sentence presentations and randomized interscan intervals (ISI) for 2-12 seconds (M = 7). Functional images (TR = 2000 ms, TE = 30 ms, flip angle = 90°, FOV = 220 X 220, 64 X 64 matrix, and slice thickness = 5 mm) with event-related bold oxygenation level dependent (BOLD) contrast were acquired using a Siemens Trio 3T MRI scanner.

Data analysis. Image processing and analyses were performed using the AFNI software package. The functional images were realigned spatially and temporally and blurred with a Gaussian kernel of 5 mm FWHM. The anatomic and functional images were registered on the standard template provided by the Montreal Neurological Institute (MNI). For statistical analyses, we used regression analysis for each condition and then compared the brain activations calculated by the regression equations of intrinsic motivation, incentive motivation, and neutral motivation. The cluster-wise threshold was set using the following values: t = 3.69, voxel sizes = 9. The activation regions were ascertained using the standard anatomical criteria.

Results. We analyzed brain activations from three conditions--intrinsic motivation, incentive motivation, and a neutral motivation control group. Compared to the brain activations seen in the neutral motivation condition, we found considerable overlap in the brain activations observed in the intrinsic motivation group and the incentive motivation group, including the posterior precuneus/cuneus (on the right side in intrinsic motivation (a.1) and bilateral in incentive motivation (b.3; b.4), the right inferior frontal gyrus, and the right middle frontal gyrus (a.2; a.3). Compared to the incentive motivation condition, brain activations unique to the intrinsic motivation condition were the right inferior parietal lobe, left superior temporal gyrus, and the bilateral anterior precuneus. Compared to the intrinsic motivation condition, brain activations unique to the incentive motivation condition were the left nucleus accumbens (b.1) and the left anterior cingulate gyrus (b.2).



(a) Intrinsic motivation – Neutral motivation **(b) Incentive motivation – Neutral motivation**

Discussion and conclusions. We found both common overlap and unique differences between brain areas associated with intrinsic motivation versus incentive motivation. These findings suggest both overlap for the two types of motivation but also unique neural underpinnings for the two types of motivation. What was unique in intrinsic motivation were activations in the anterior precuneus, which is associated with judgments of self-relevance and whether the task depicted in the sentence expressed the needs and interests of the self or not. In incentive motivation, there were unique brain activations in the nucleus accumbens and the anterior cingulate gyrus, which is related to the anticipation of rewards or beneficial outcomes and the making of decisions on the basis of evaluation of rewards and benefits respectively. We conclude that the neural bases of intrinsic motivation can be distinguished from the neural bases of incentive motivation.

References. Ryan, R., & Deci, E. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*, 68-78.