Inferior frontal gray matter is increased in healthy individuals with high risk averse behaviour.

Satomi Higuchi[1], Keigo Inukai[2], Hackjin Kim[3], Tetsuya Matsuda[4], Masamichi Sakagami[5], and Tatsuya Kameda[6]

[1]Center for Experimental Research in Social Science, Hokkaido University, Sapporo, Hokkaido, Japan, [2]Graduate School of Economics and Business Administration, Hokkaido University, Japan, [3]Department of Brain and Cognitive Engineering, Korea University, [4]Tamagawa University, Japan, [5]Tamagawa University, [6]Hokkaido University, Japan

<Background> The relationships between risk and decision-making have been studied in individuals with a history of substance abuse such as cocaine, with previous neuroimaging studies of drug abuse subjects showing functional changes in oribito-frontal cortex (OFC) [1], and voxel-based morphometry (VBM) studies showing substance-dependent individuals have smaller gray matter volume in medial prefrontal cortex (mPFC) [2]. In these clinical studies, the `Iowa gambling task` was used to measure risk attitude in relation to addiction, however the concept of risk decision-making has also been widely studied in economics, and is commonly explained with the 'mean-variance utility model'. This model is based on value, variance and weight for risk attitude. Unlike the Iowa gambling task, this model does not include outcome feedback, and is therefore purely representative of decision-making. Utilizing this basic model, previous neuroimaging results have shown that risk attitude relates to anterior cingulate cortex (ACC) and inferior frontal gyrus (FG) activation [3] but until now no study has tested brain morphometry in relationship to risk attitude. In this work we apply voxel based morphometry (VBM) of T1 weighted MRI to assess the relationship between risk attitude and the volumes of brain regions known to be implicated in these decision making processes.

<Method> Twenty-seven university students (age 20.93 years old) with no relevant medical history participated in this study. Written consent was acquired and ethics approved by the center for experimental research in social sciences, Hokkaido University ethics committee. For testing risk attitude, volunteers underwent a gambling task, which involved choosing from two different roulettes (above or below) with three different levels of monetary value (red, green or blue) with different ratios of values with equal probabalility (Figure 1). These values consisted of 36 different parameter sets which had different total values and variance and were designed to be orthogonal to each other. High resolution T1 weighed images were acquired using 3 tesla MRI (Siemens Trio Tim). Image processing and analyses were conducted with VBM implemented in Statistical Parametric Mapping 8.

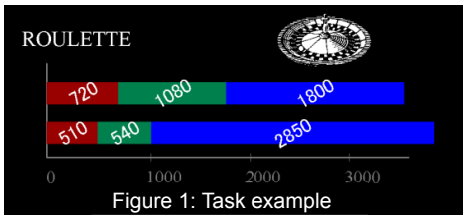

Figure 1: Task example

<Results> Risk attitude of the individual participants were estimated with a softmax function based on the chosen pattern of each participant during the behavioural test. This risk attitude parameter indicates risk avoidance level and was used for a VBM analysis to find the correlated brain volumes. T1 images were segmented into gray and white matters. VBM analysis showed significantly larger gray matter volume in left IFG and ACC (p<0.001) (see coronal slices at Y=39 and Y=14 respectively in Figure 2).

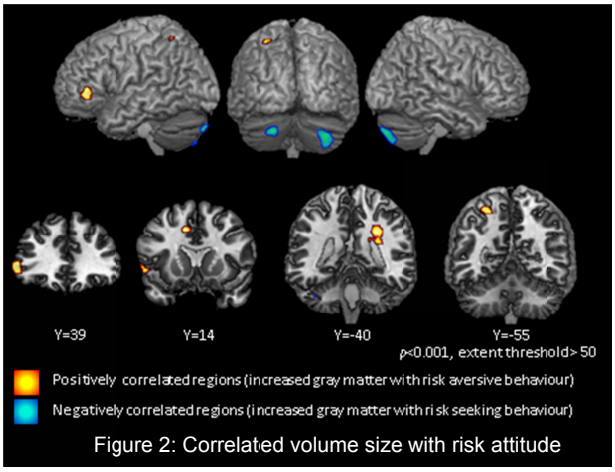

Figure 2: Correlated volume size with risk attitude

<Discussion> Addictive behaviour has previously been shown to be predicted with specific regional brain structure [4], suggesting different brain morphometry causes different behavioural outcome. In this study, the morphometric correlation to risk attitude was present in IFG and ACC as in previous functional studies, suggesting that both IFG and ACC are involved as a weighting system as is represented by the mean variance utility model. However, the brain regions such as mPFC and OFC that were implicated in previous clinical risk attitude studies, were not present in this study, which might suggest that two weighting systems are involved in the determination of risk attitude; one for the decision-making state and the other for the controlling of feedback perception. These results have implications for the assessment of clinical populations with addictive disorders.

<Reference>

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