Reduced impact of regret in economic decision-making for individuals with major Depressive Disorder (MDD) – an fMRI study

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Abstract

Past research has established a connection between regret (negative emotions connected to cognitions about how past actions might have achieved better outcomes) and clinical depression (MDD). It is yet to be investigated, however, how cognition related to regret and other counterfactual values-based emotions may explain behavioural and neural differences between MDD and healthy participants. We compared neural activity and choices among 18 patients with Major Depressive Disorder to 20 demographically-matched controls in regret-based economic decision-making task, wherein the task incorporated both factual and counterfactual values in the decision-making process. Behaviourally, individuals with higher depressive symptoms were less adept in incorporating prospective regret signals during choice and were also less sensitive to the experience of regret in their affect ratings – demonstrating the common emotional blunting observed in depression. In response to greater regret across both win and loss trials, patients with higher depression scores (Beck's depression inventory, BDI) manifested lower prefrontal and Anterior Cingulate (ACC) activations in areas previously associated with the processing of regret. Our results provide evidence on how MDD patients differentially engage counterfactual values in their decision-making and how it may be related to the atypical brain activations..

Introduction

It has been argued that depression involves alterations in memory processes, attention, mental schemas, and the reward systems of the brain. Regret-based decision-making is another process which may be altered in depression, which may have adverse consequences in the adaptation of behavior in response to such emotions. In this regard, there has been arguments for both an increased feeling of regret due to unstable self-representation in depression , or the contrary – a reduced response to regret related to emotional bluntness as is commonly observed in depression.

We addressed two main questions:
1. Do individuals with MDD differ in economic decision-making as a funct6ion of regret and other counterfactual outcome values/emotions?
2. Is the evaluation of re

Methodology

Participants: 18 MDD (mean age = 35.3, Female=11) , 20 Healthy controls (mean age = 32.3, Females=10).

Task: Probabilistic gambling decision-making task with counterfactual information (below) + BDI.
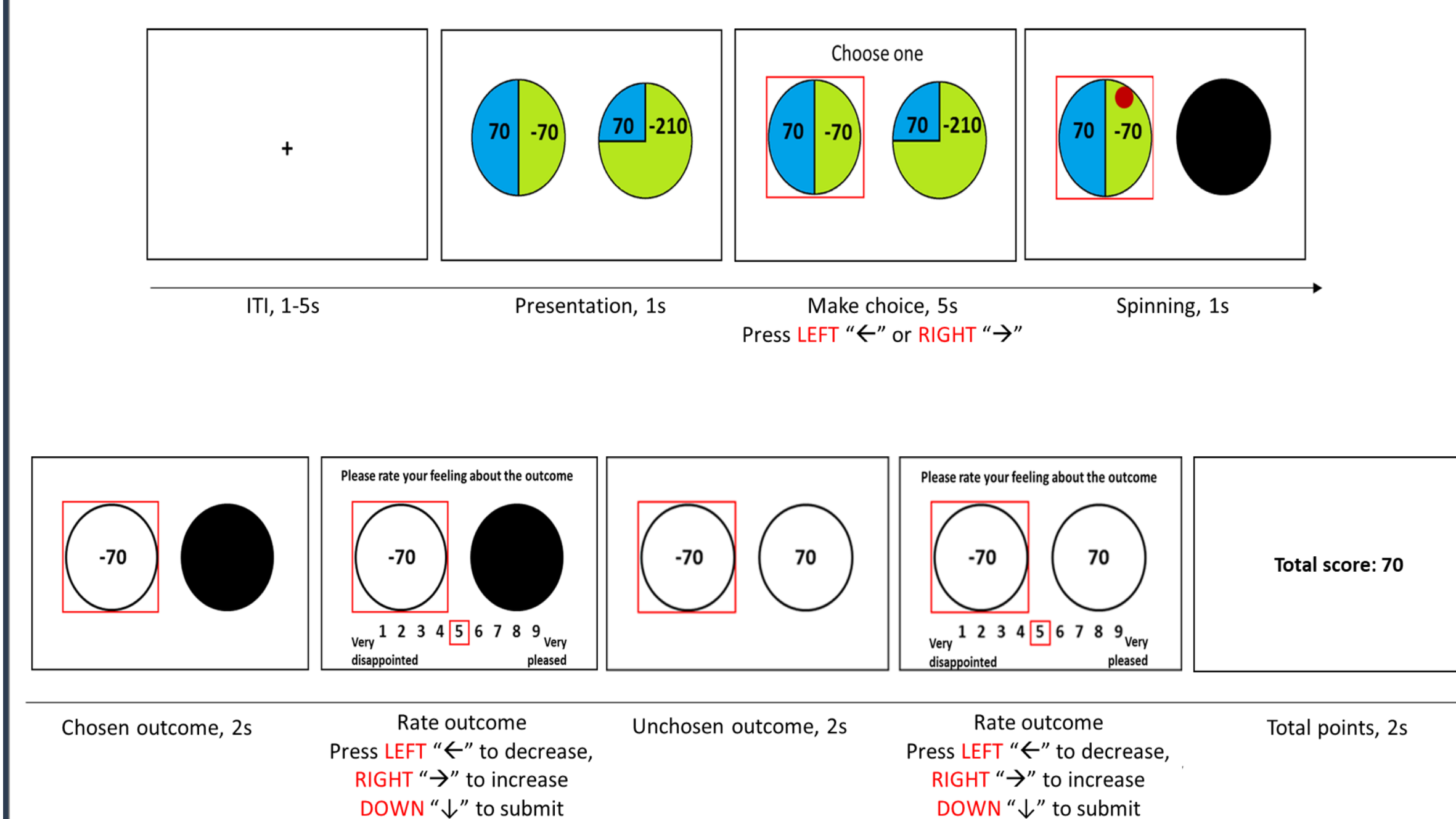
FMRI processing: Data processing was carried out using FEAT (FMRI Expert Analysis Tool) Version 6.00, part of FSL (FMRIB's Software Library, www.fmrib.ox.ac.uk/fsl). The following pre-statistics processing was applied; motion correction using MCFLIRT [Jenkinson 2002]; non-brain removal using BET [Smith 2002]; spatial smoothing using a Gaussian kernel of FWHM 5mm; grand-mean intensity normalization of the entire 4D dataset by a single multiplicative factor; highpass temporal filtering (Gaussian-weighted least-squares straight line fitting, with sigma=50.0s). Registration to high resolution structural and standard space images was carried out using FLIRT [Jenkinson 2001, 2002] with fieldmap correction. Registration from high resolution structural to standard space was then further refined using FNIRT nonlinear registration [Andersson 2007. Time-series statistical analysis was carried out using FILM GLM with local autocorrelation correction [Woolrich 2001]. Group-level analysis was carried out using mixed-effect modelling of lower-level contrasts using FSL FLAME1, results were cluster-level thresholded at FWE p<.05 with cluster defining threshold at z=2.3.

Results
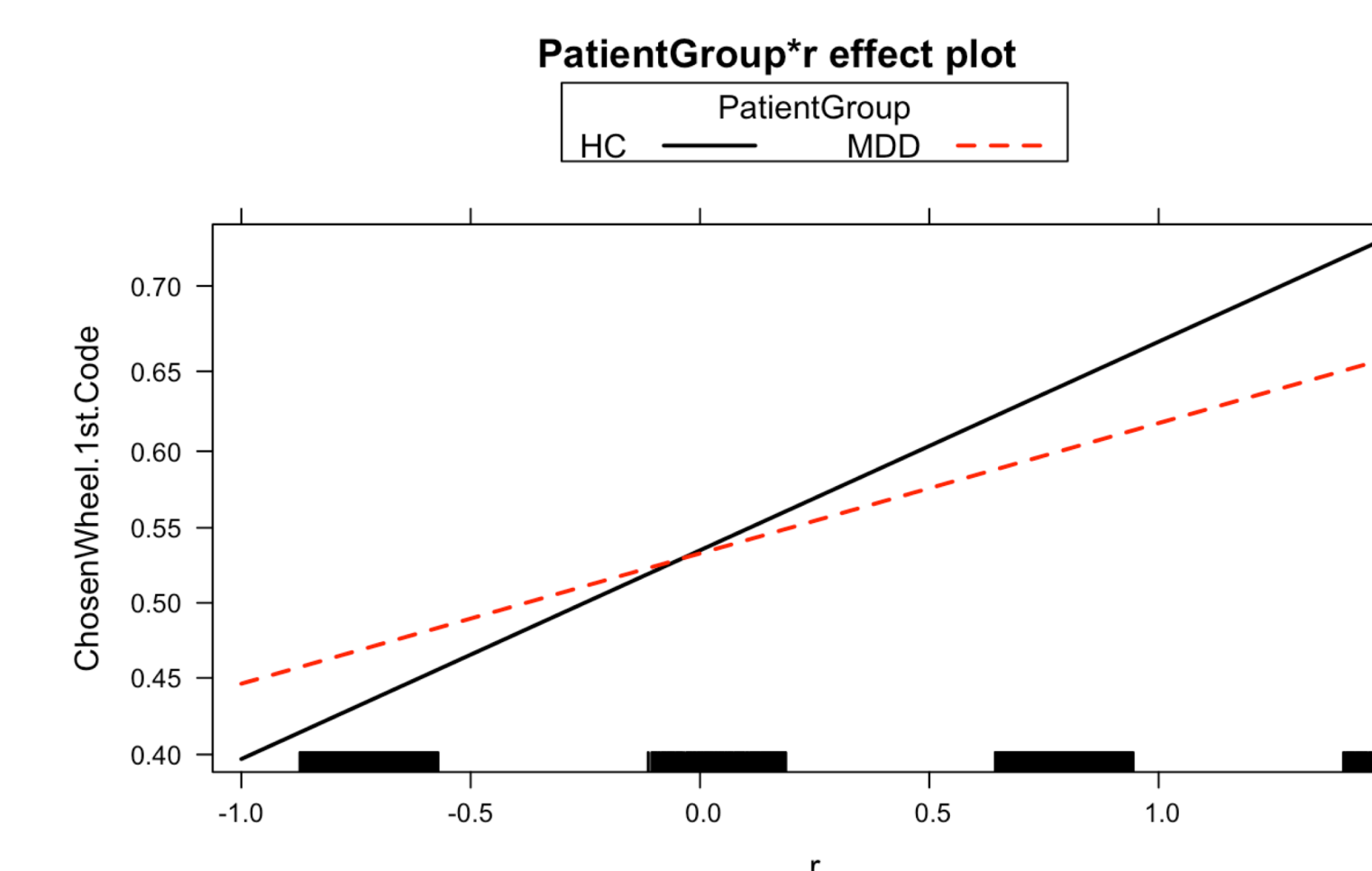
Behavioral results: Mixed-effects logistic regression model

Test: Choice ~ (e + d+ r + Lag1Regret +cumR)*PatientGroup + Age + Sex + (1 | Subject)

e = expected value d=disappointment r = prospective regret
Lag1Regret = regret magnitude in previous trial
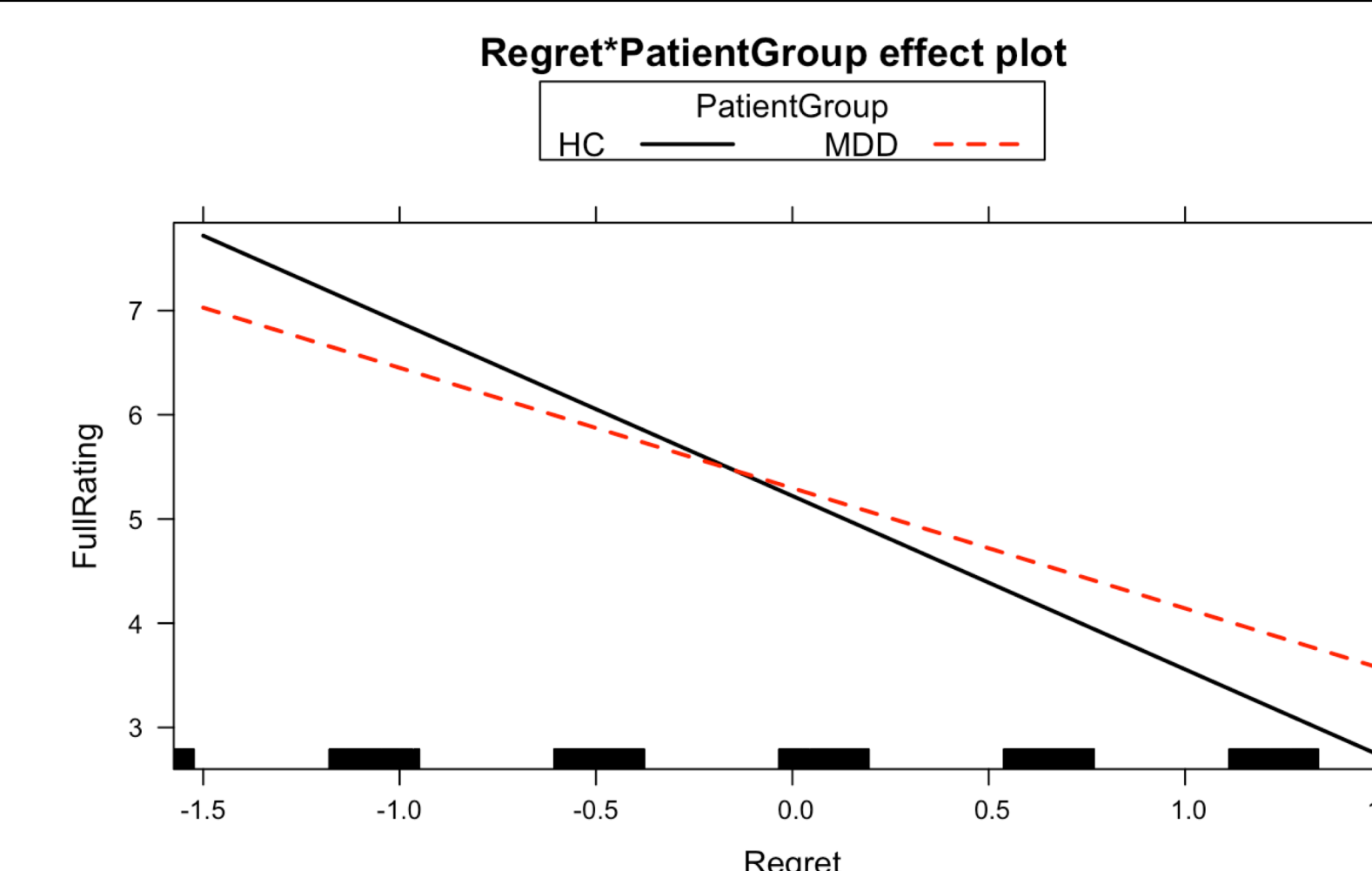cumR = cumulative (average) regret from previous trials

Results: e, r, and r x PatientGroup are significant predictors of choice (below).

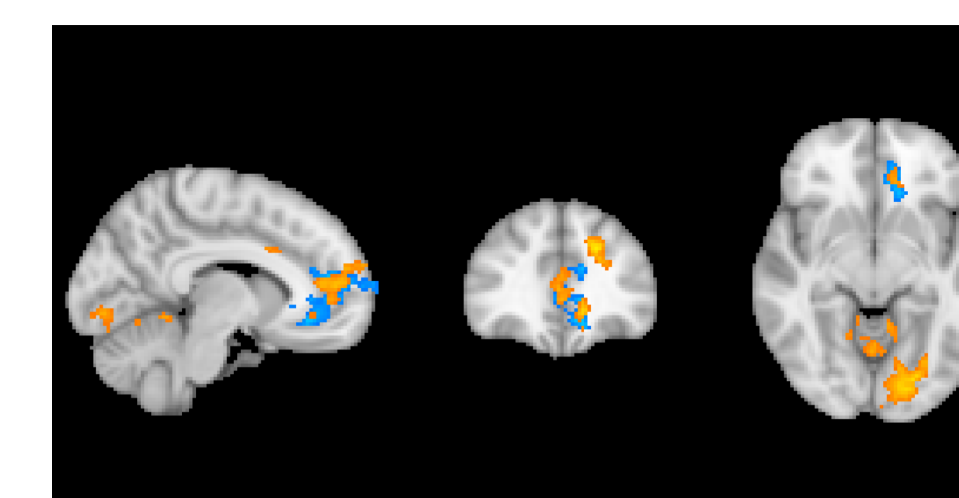Test: FullRating ~ (Chosen.Obtained + Regret)*PatientGroup + Age + Sex + (1 | Subject)

Regret = Unchosen outcome – chosen outcome
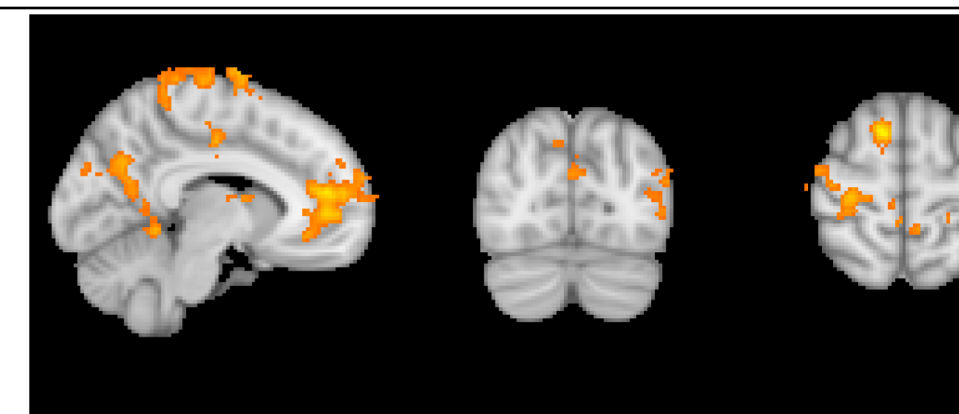Result: Chosen outcome, Regret & Regret x PatientGroup significant predictors.

FMRI results:
- Healthy controls and MDD patients showed increased ACC activation in response to increasing regret levels. (below)

Higher depression scores were associated with lower ACC activation (below)

Conclusion

There is consistent evidence that depressed individuals have alterations in functioning of the ACC, and our results corroborate this evidence in the context of regret-based decision-making. Studies have found decreased activity of rostral cingulate gyrus during reward selection and anticipation in a gambling task. An fMRI study of paediatric depression using a gambling task found decreased ACC activity during the decision phase, especially during a high-magnitude reward condition. The same study also found decreased ACC activity during the outcome phase in response to losses and small gains.

We also find consistent behavioural differences in the response to regret in depressed individuals, such that it support the emotional bluntness perspective – depressed individuals are less sensitive to the emotion of regret in both adapting their behaviour in response to it as well as in the affective experience of regret.

We therefore show that depressed individuals display distinct behavioural and neural representations in regret-based economic decision-making tasks

References

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[Andersson 2007a] J.L.R. Andersson, M. Jenkinson and S.M. Smith. Non-linear optimisation. FMRIB technical report TR07JA1, 2007.