Relationship between Brain Regions Associated with Self and Moral Functioning in Moral Judgment

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Abstract Submission

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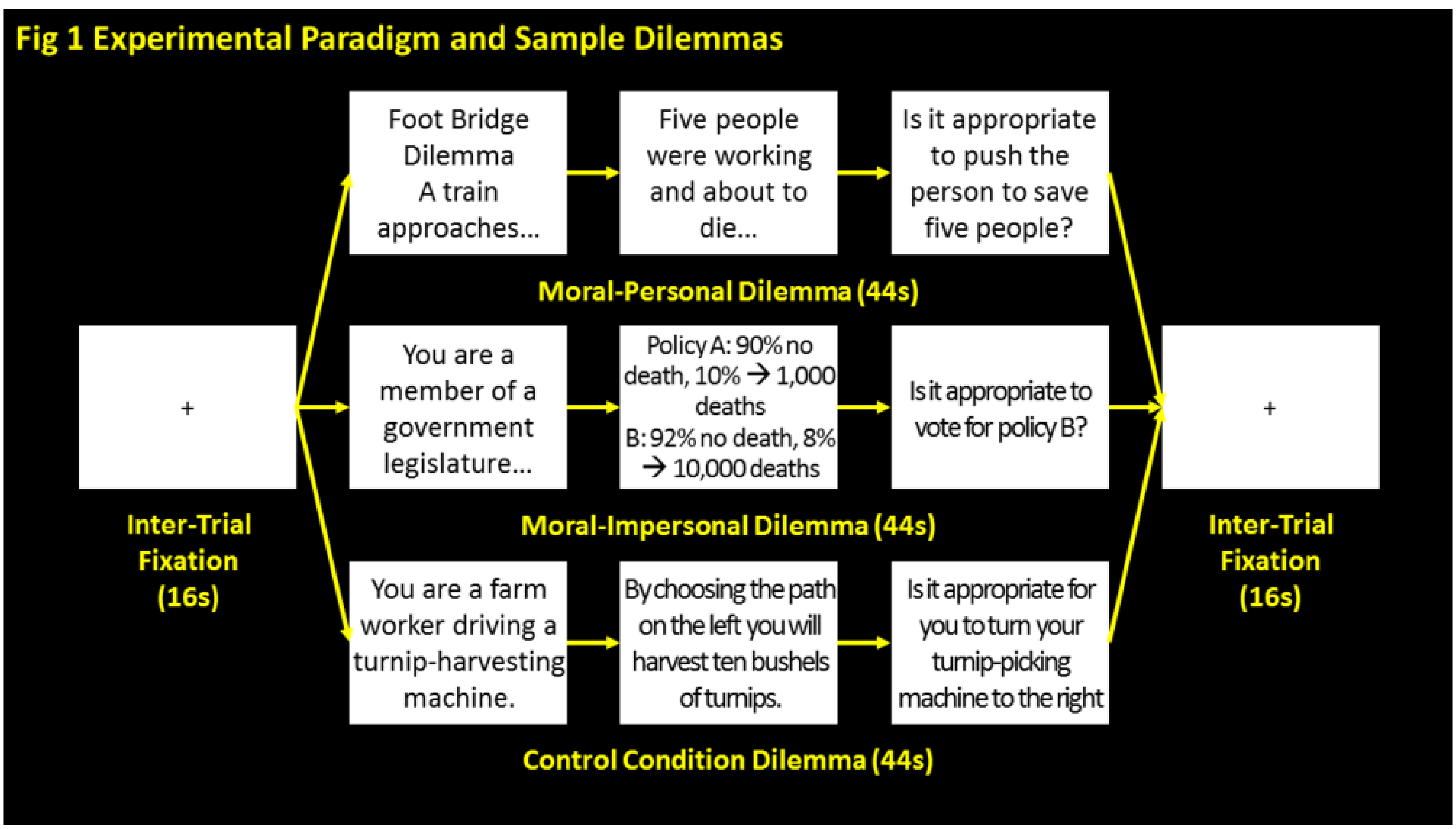
Introduction:

Moral psychologists argue that moral self associated with self-related psychological processes significantly influences moral functioning including moral affection, cognition, and motivation [1,2]. However, there have not been any previous neuroimaging studies that investigated the modulatory role of self-related processes in moral functioning. In the present study, by conducting psycho-physiological interaction (PPI) and Granger causality analyses of neuroimaging data acquired while subjects were solving moral dilemmas, we examined how default mode network (DMN) regions, which are associated with selfhood-related processes in part, such as self-reflection, self-referencing, self-related emotional and episodic memory processing, the posterior cingulate cortex (PCC) and medial prefrontal cortex (MPFC) in particular [3], interact with and affect activity in other brain regions related to moral functioning.

Methods:

Subjects: 16 right-handed healthy adults (mean age 28.59 years, SD 3.18 years; 8 females; 8 Koreans, 8 Americans) participated in the experiment. Data acquisition: Functional images were scanned at 3T (GE Signa 750, spiral-in/out sequence, TR = 2s). Respiration and cardiac (pulse oximetry) responses were recorded using a respiratory belt and pulse-ox sensor attached to a finger. The data was initially acquired and used for a cross-cultural social neuroscientific experiment [4]. **Experiment**: Each subject was requested to solve 22 moral-personal, 18 moral-impersonal and 20 neutral dilemmas during functional scanning sessions [4,5,6] (Fig1). Each trial consisted of a 46-sec decision making and 14-sec inter-trial fixation phases. **Data analysis**: The acquired images were analyzed using SPM 8 and MATLAB. (1) Pre-processing consisted of physiological noise reduction [7,8], slice time correction, motion correction, co-registration, normalization, and spatial smoothing (Gaussian FWHM = 8mm). Demographic variables (ethnicity, age, gender) were included in the statistical model as covariates. (2) A whole-brain t-test examined which regions were significantly activated under both moral-personal and moral-impersonal conditions compared to the control condition. (3) A PPI analysis was performed based on two seed regions, the PCC (MNI [0, -54, 28]) and MPFC (MNI [0, 54, 12]), to investigate which regions showed significant interaction with these seed regions. (4) Additional Granger causality analysis focusing on a region displaying mixed PPI results was conducted using The MVGC Multivariate Granger Causality Toolbox [9].



Results:

(1) Task Activation: In both conditions, regions associated with the DMN were significantly activated as presented in previous studies [3,4,5] (Fig2). More regions showed significant activity under the moral-personal condition compared to the moral-impersonal condition.
(2) PPI Analysis: Under the moral-personal condition, the dorsolateral prefrontal (DLPFC) and orbitofrontal cortices, cerebellum, brainstem, midbrain, and anterior insula (AI) showed significant positive interaction with both the PCC and MPFC. However, the posterior insula (PI) showed significant negative interaction with both seed regions (Fig3(a/b)). Under the moral-impersonal condition, although the overall result was identical to that under the moral-personal condition, the interaction between the MPFC and DLPFC was insignificant (Fig3(c/d)).
(3) Granger Causality Analysis: Only under the moral-personal condition, was significant Granger causality from the PI to AI and MPFC, MPFC to AI, and AI to PCC found (Fig4). However, no significant causality was discovered under the moral-impersonal condition.

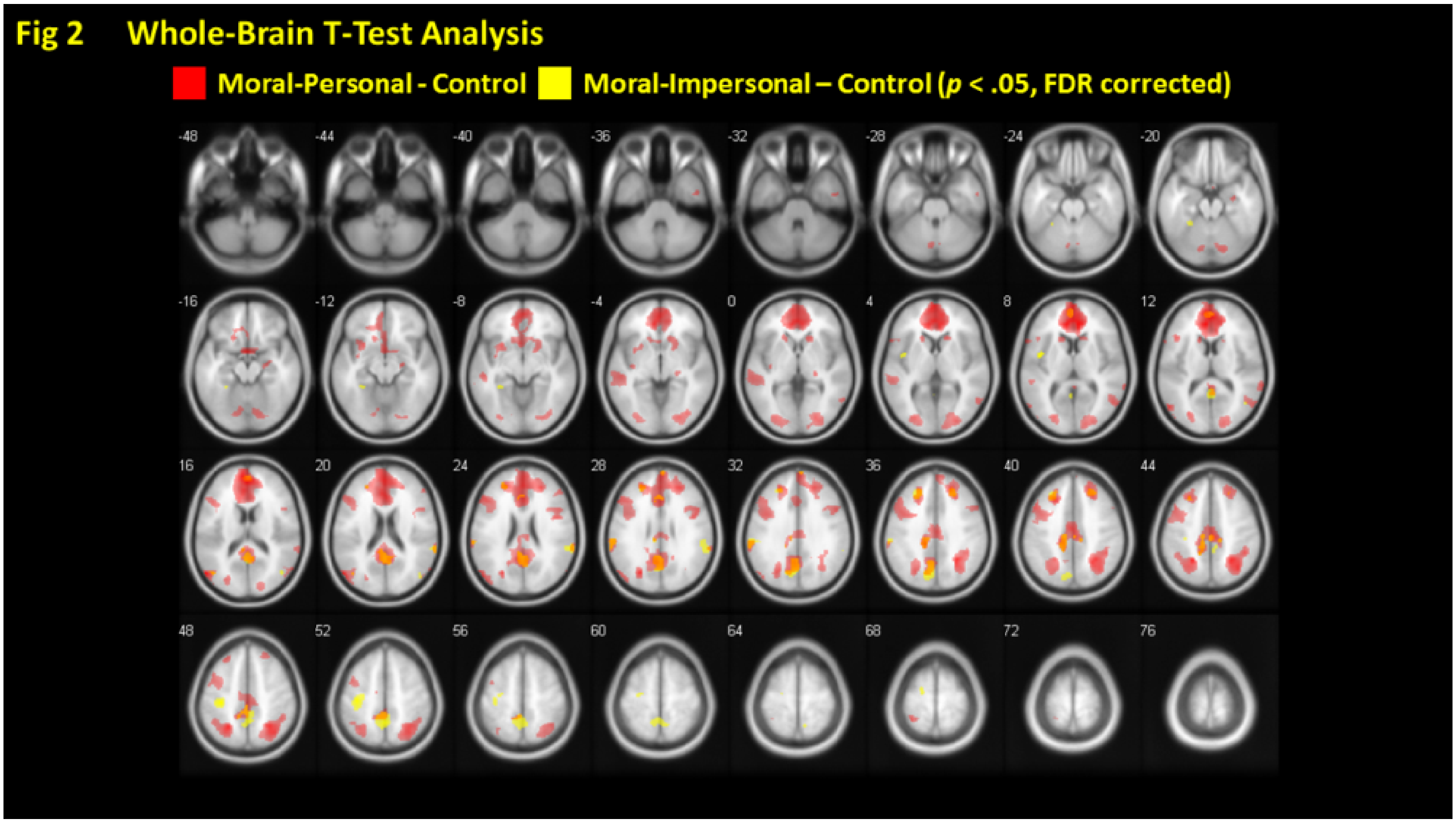


Fig 2 Whole-Brain T-Test Analysis
Moral-Personal - Control
Moral-Impersonal – Control (p < .05, FDR corrected)
-48
-44
-40
-36
-32
-28
-24
-20
-16
-12
-8
-4
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
64
68
72
76

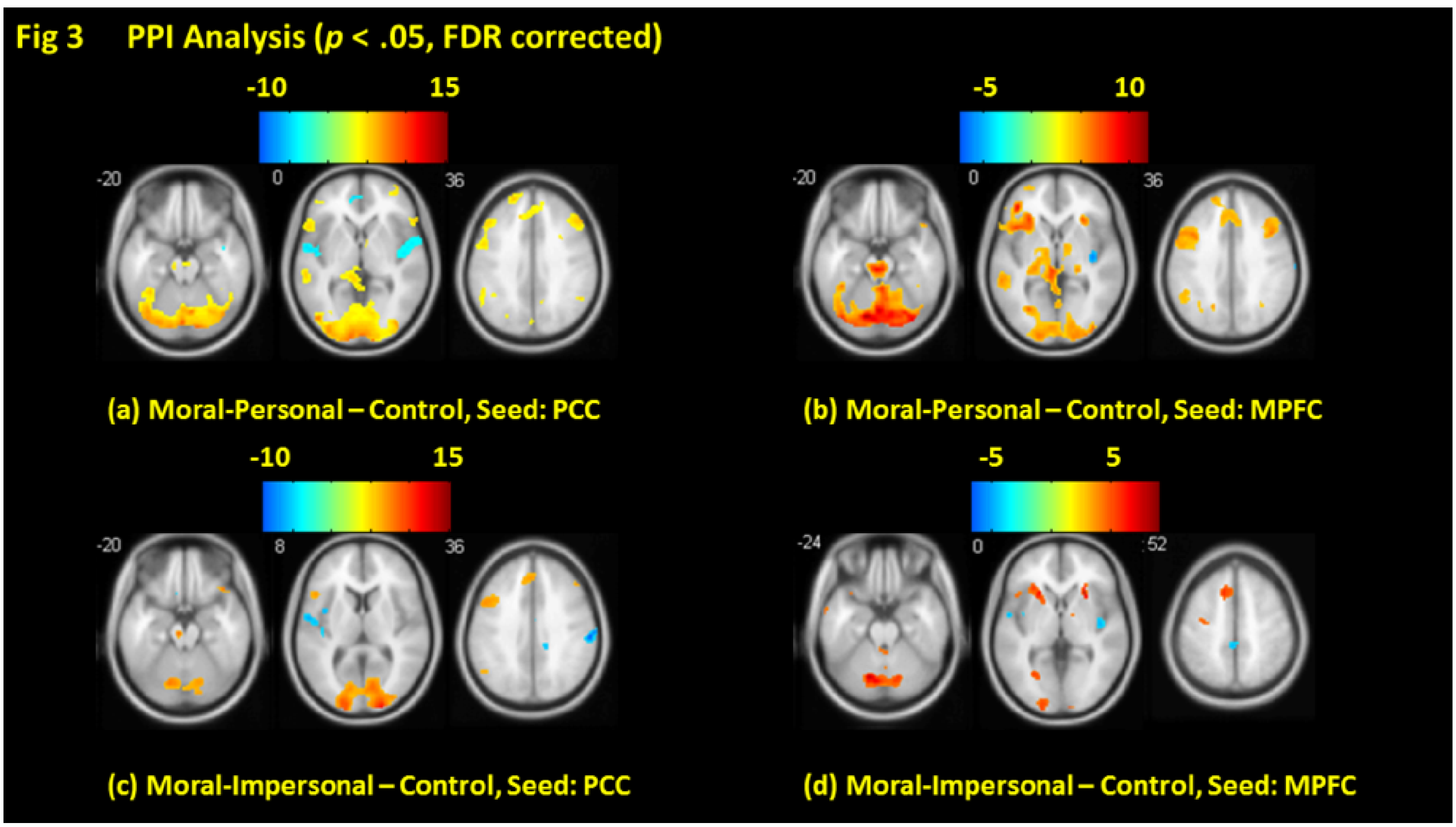
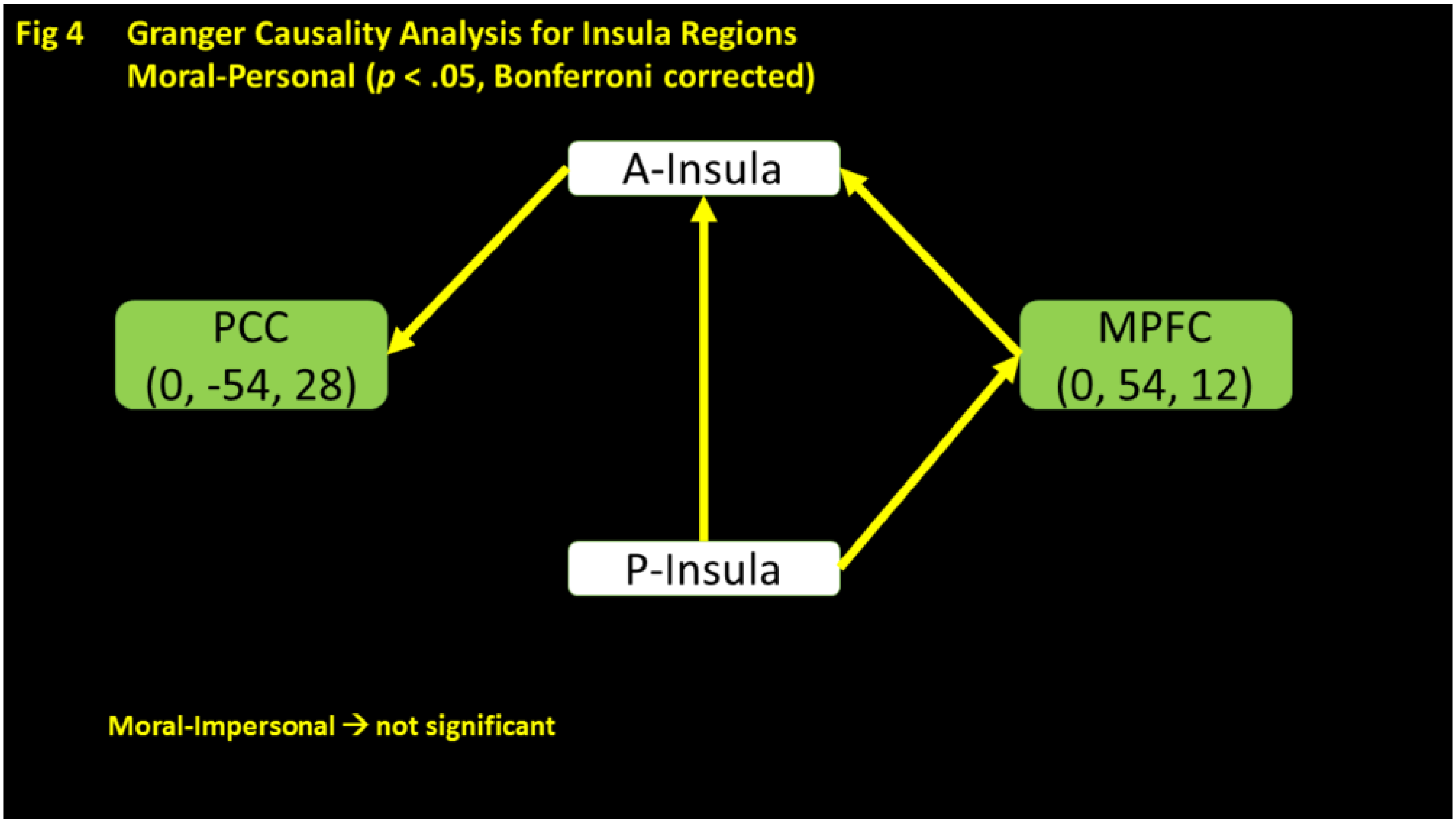


Fig 3 PPI Analysis (p < .05, FDR corrected)
-10
15
-20
0
36
(a) Moral-Personal – Control, Seed: PCC
-5
10
-20
0
36
(b) Moral-Personal – Control, Seed: MPFC
-10
15
-20
8
36
(c) Moral-Impersonal – Control, Seed: PCC
-5
5
-24
0
52
(d) Moral-Impersonal – Control, Seed: MPFC



Conclusions:

Regions of the DMN that take part in selfhood-related processing significantly interacted with other regions associated with moral functioning in moral judgment consistent with our hypothesis. In addition, the result of the Granger causality analysis indicated that there were significant influences between DMN and morality-related regions.

Higher Cognitive Functions:

Decision Making

Reasoning and Problem Solving [2]

Social Neuroscience:

Self Processes

Social Cognition [1]

Social Neuroscience Other

Keywords:

Cognition

FUNCTIONAL MRI

Other - Morality;Moral Judgment;Self;Default Mode Network;Psycho-physiological Interaction Analysis;Granger Causality;Insula;Moral Psychology;

[1|2] *Indicates the priority used for review*

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Task-activation

Healthy subjects only or patients (note that patient studies may also involve healthy subjects):

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Internal Review Board (IRB) or Animal Use and Care Committee (AUCC) Approval. Please indicate approval below. Please note: Failure to have IRB or AUCC approval, if applicable will lead to automatic rejection of abstract.

Yes, I have IRB or AUCC approval

Please indicate which methods were used in your research:

Functional MRI

For human MRI, what field strength scanner do you use?

3.0T

Which processing packages did you use for your study?

SPM

Other, Please list - The MVGC Multivariate Granger Causality Toolbox

Provide references in author date format

If Yes, enter references below.

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